ORDNANCE

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Redstone Ballistic Missile

MAY-JUNE 1956

How you can profit from a nation-wide search for accuracy

SCIENTISTS at the Massachusetts Institute of Technology were stymied on a top secret National Defense project. Some extremely accurate plug and ring gages were needed, but where to find a manufacturer capable of tackling an order calling for such extreme accuracy was the problem. The search eventually led to The Timken Roller Bearing Company. The M.I.T. engineers came to our Canton, Ohio, plant, were impressed with our gage facilities and our gage laboratory—acknowledged as one of the U. S. industry's finest—and asked if we would help them out.

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ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness Now in Its 36th Year

VOL. XL | MAY-JUNE 1956 | NO. 216

The Cover.—*The Redstone ballistic missile, with a range of approximately 250 miles, is being readied for a test firing at Patrick Air Force Base, Fla. The missile is transported and erected by the vehicle at the left and is serviced by the huge rolling tower at right (Army photo).*

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Advertising Representative: Thomas O. Woolf & Son, Inc., 70 E. Forty-fifth Street, New York 17, N. Y.

ORDNANCE is published bimonthly by the American Ordnance Association, 708 Mills Building, Washington 6, D. C. Second-class mail privileges authorized at Washington, D. C. Subscription rate: Continental United States and possessions, $4.50 annually in advance; foreign, $6.00.

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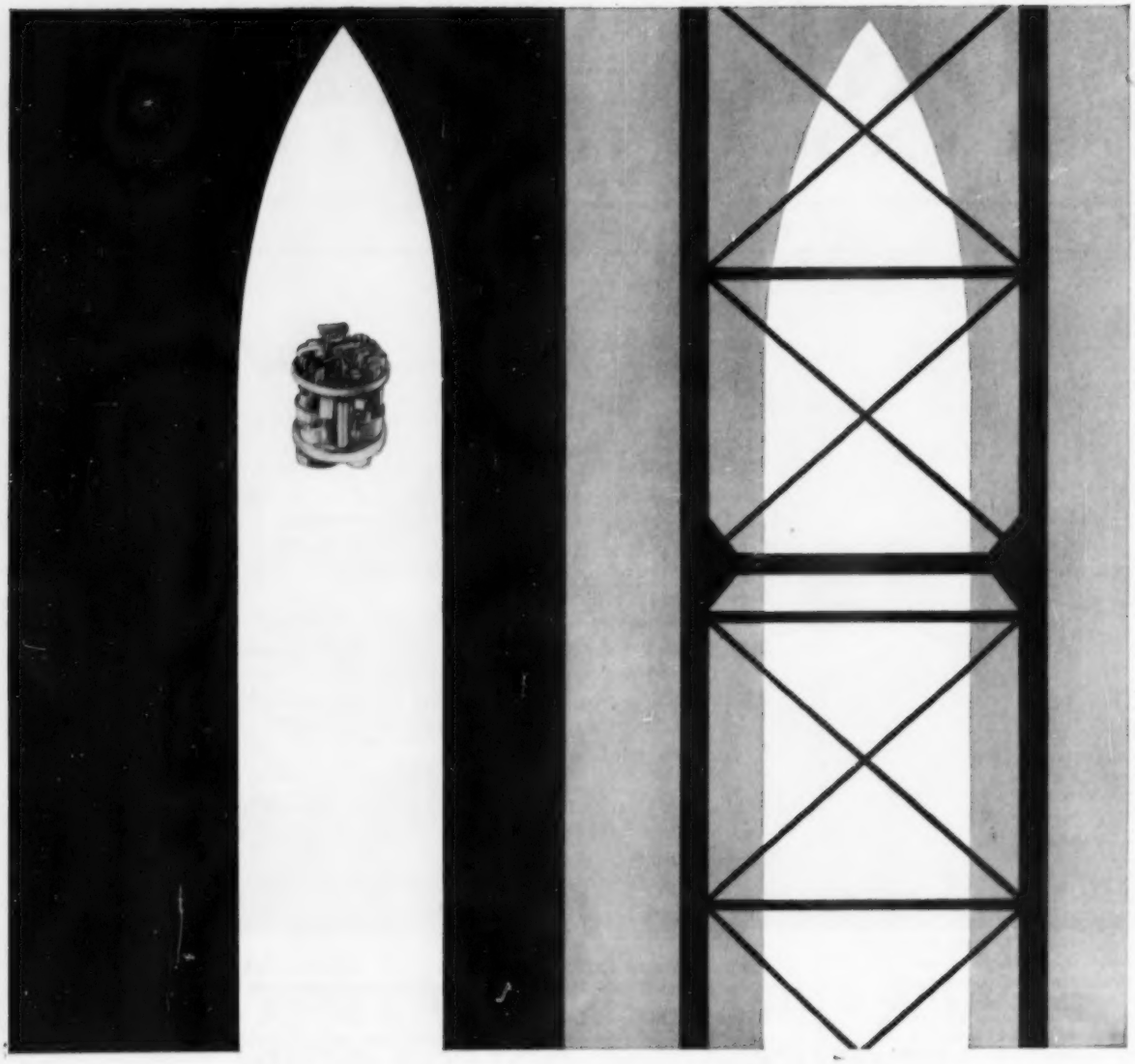

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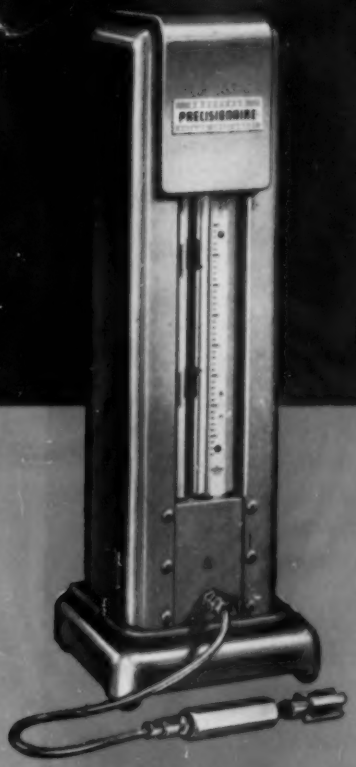

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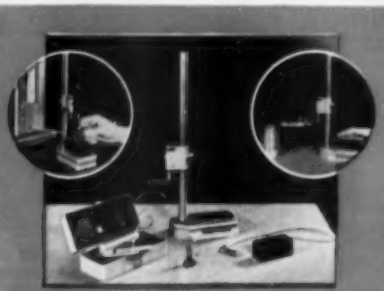

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SHEFFIELD

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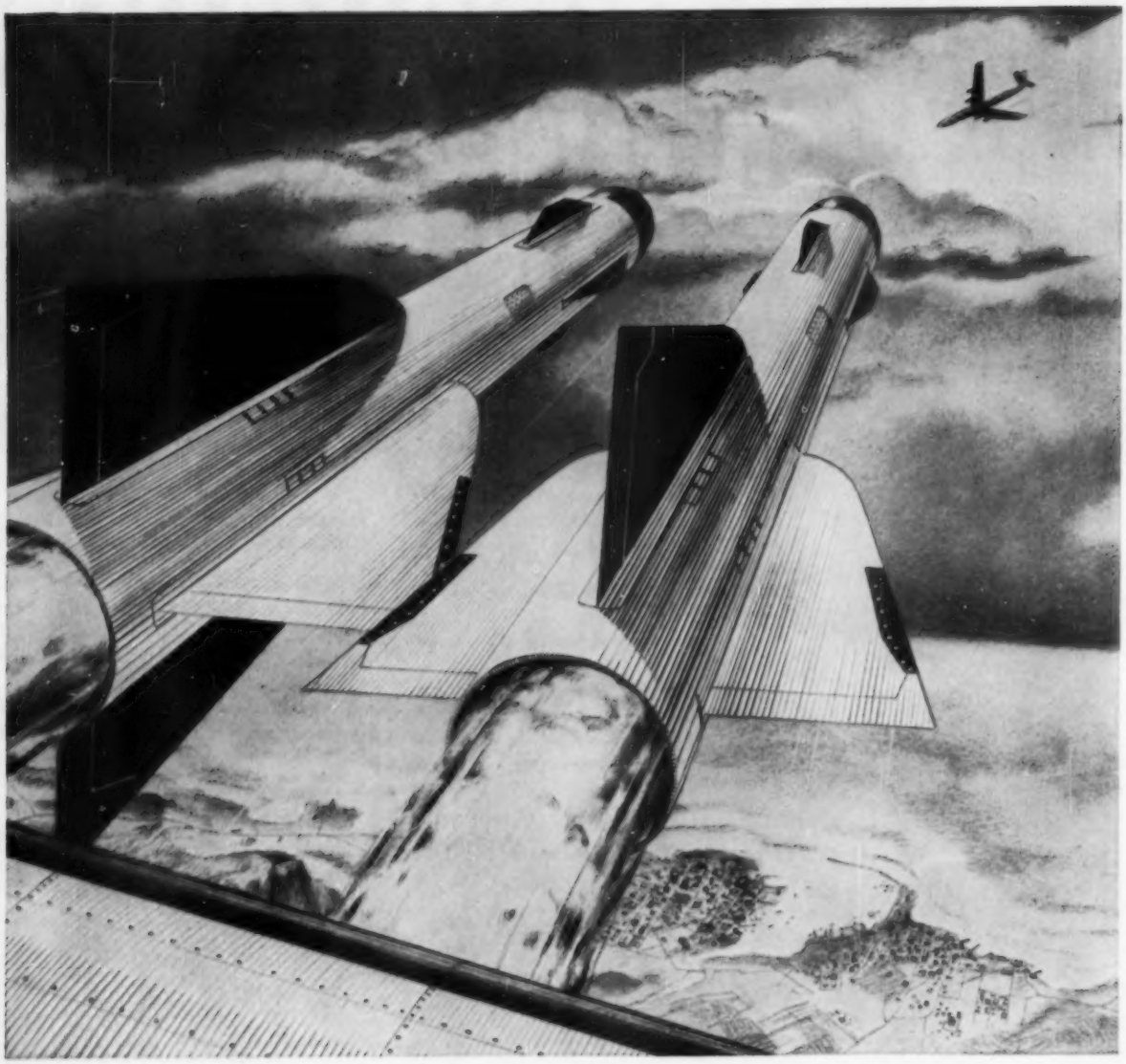

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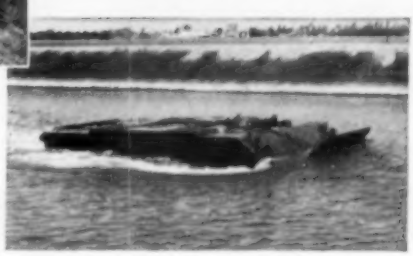

Although primarily a land vehicle, the M59 is capable of swimming rivers and lakes with ease, while fully loaded.

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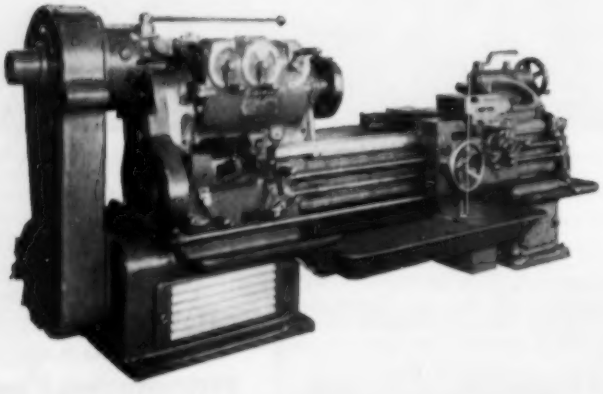

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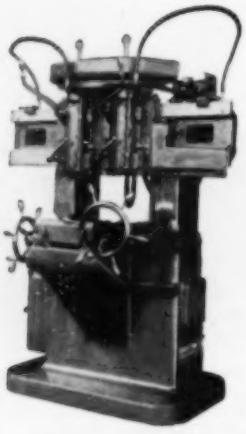

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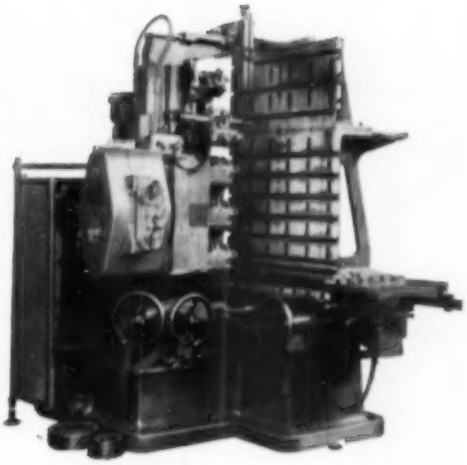

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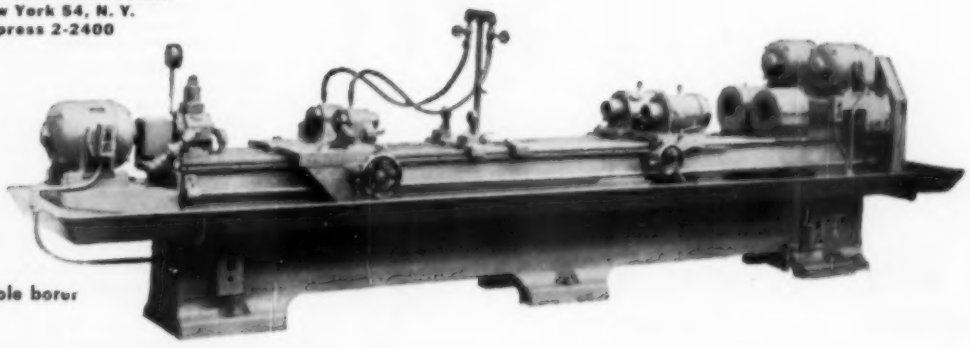

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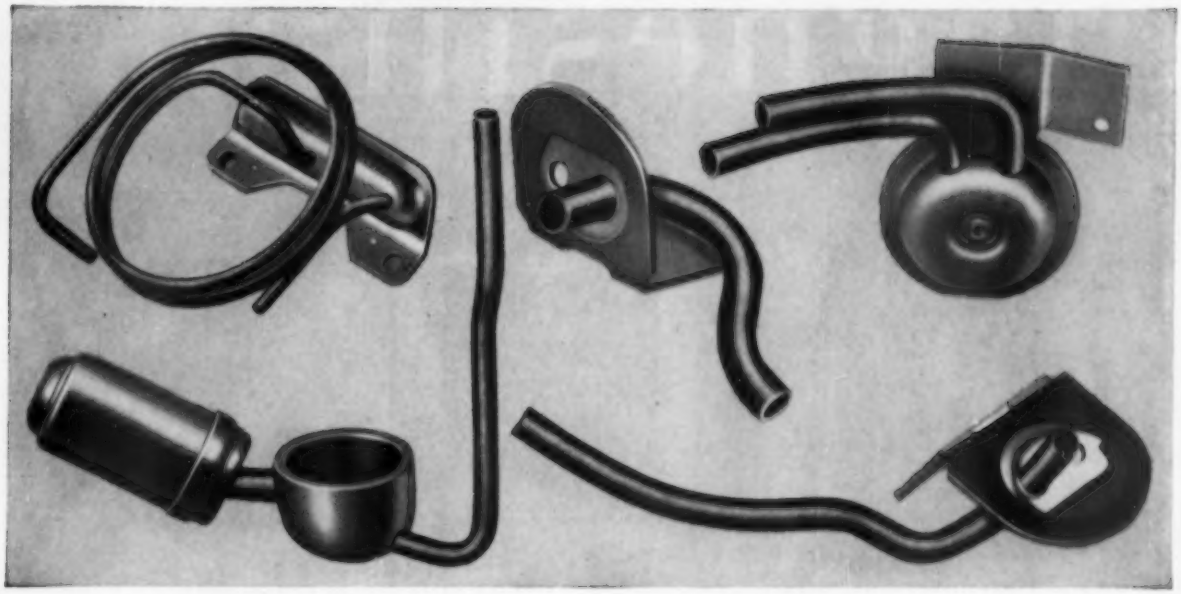

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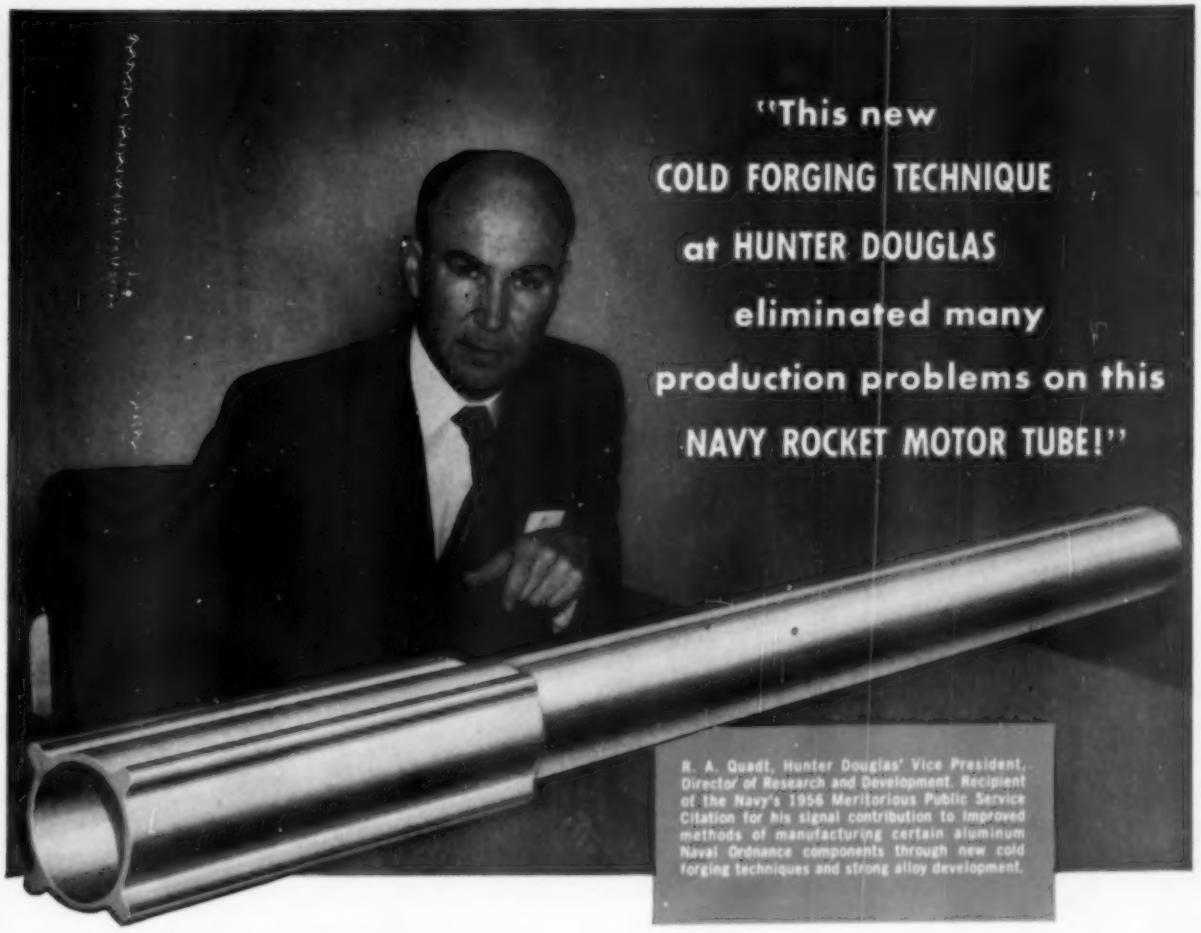
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eliminated many
production problems on this
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Production of "King Size" Rocket Motor Tubes was hampered by two basic problems... the first, *obtaining a plain motor tube that met the very close tolerances*–dimensional, concentricity, and straightness; the second, *attaching the separately ribbed channel ring to the motor tube.* The latter was a costly assembly operation with the attendant problem of aligning the channel ring with the axis of the motor tube which, at best, left much to be desired.

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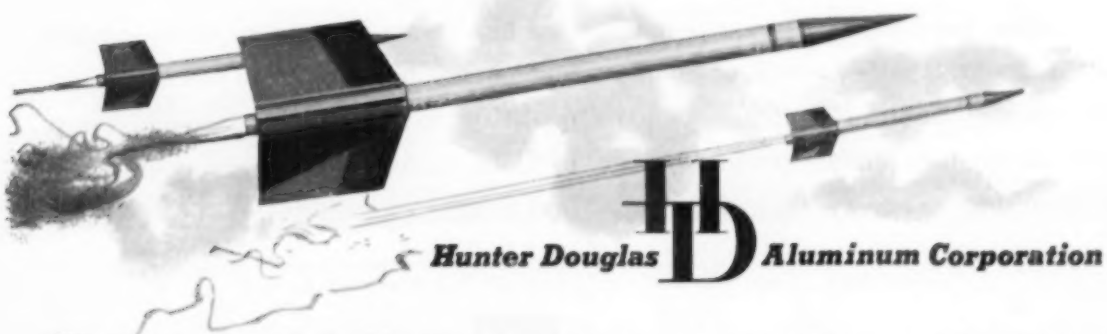

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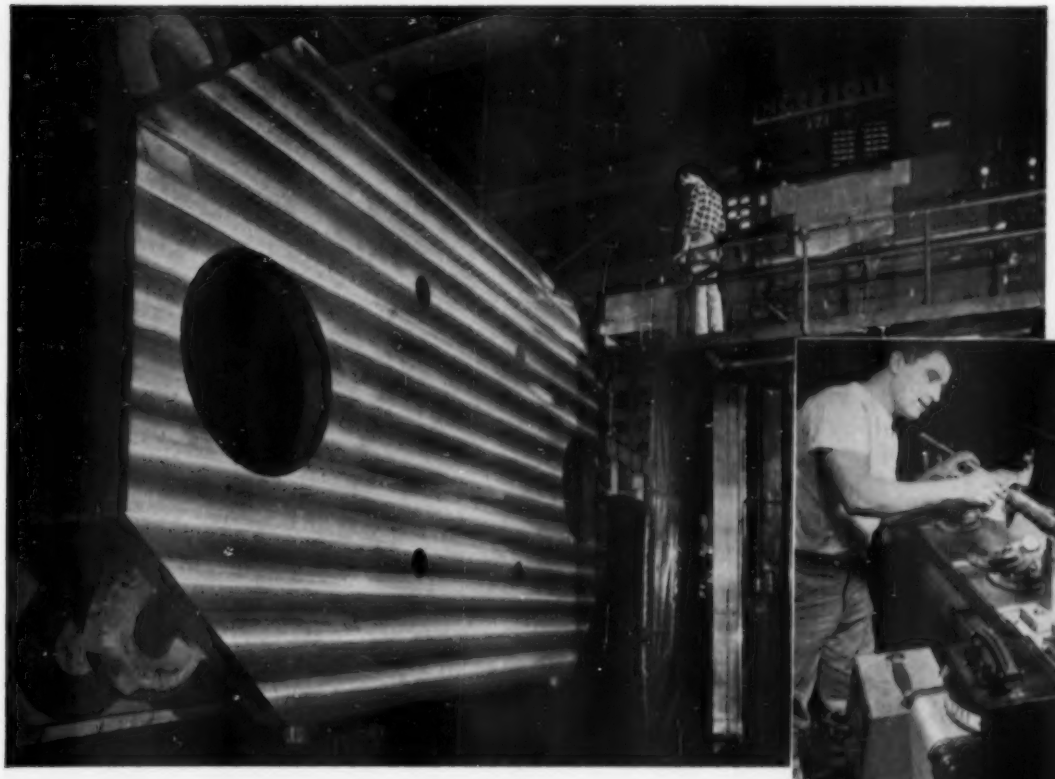

Mass and precision: *At left,* a large horizontal boring mill at Bliss' Canton plant is used to finish machine 200-ton weldment for 25,000 ton press. *Directly above,* an electronic recording gage checks three separate tapers in the chambers of barrels for 20 mm machine guns. Tolerances are held to 0.002".

Before you decide who's going to build it...

You're wise to get a bid from BLISS

The reasons are quickly summed up: flexible manufacturing facilities backed by long experience and a record of successful performance on past contracts, both government and civilian. Whether you want a few hundred-ton units or many thousands of small parts weighing a few pounds each, be sure to check with Bliss before you buy.

BLISS offers you... the experience gained in the production of equipment like

• aircraft carrier catapults • 20 mm machine guns • gun mounts • ammunition machinery • torpedoes • shells • tank cupolas

plus facilities that include • 11 U.S. plants—two million square feet of floor space and, at present day values, about a $44,000,000-inventory of metalworking tools • Four foundries pouring steel, iron and Meehanite castings, including the largest and heaviest types • Two welding departments with equipment to cut out, weld, preheat and anneal weldments weighing hundreds of tons.

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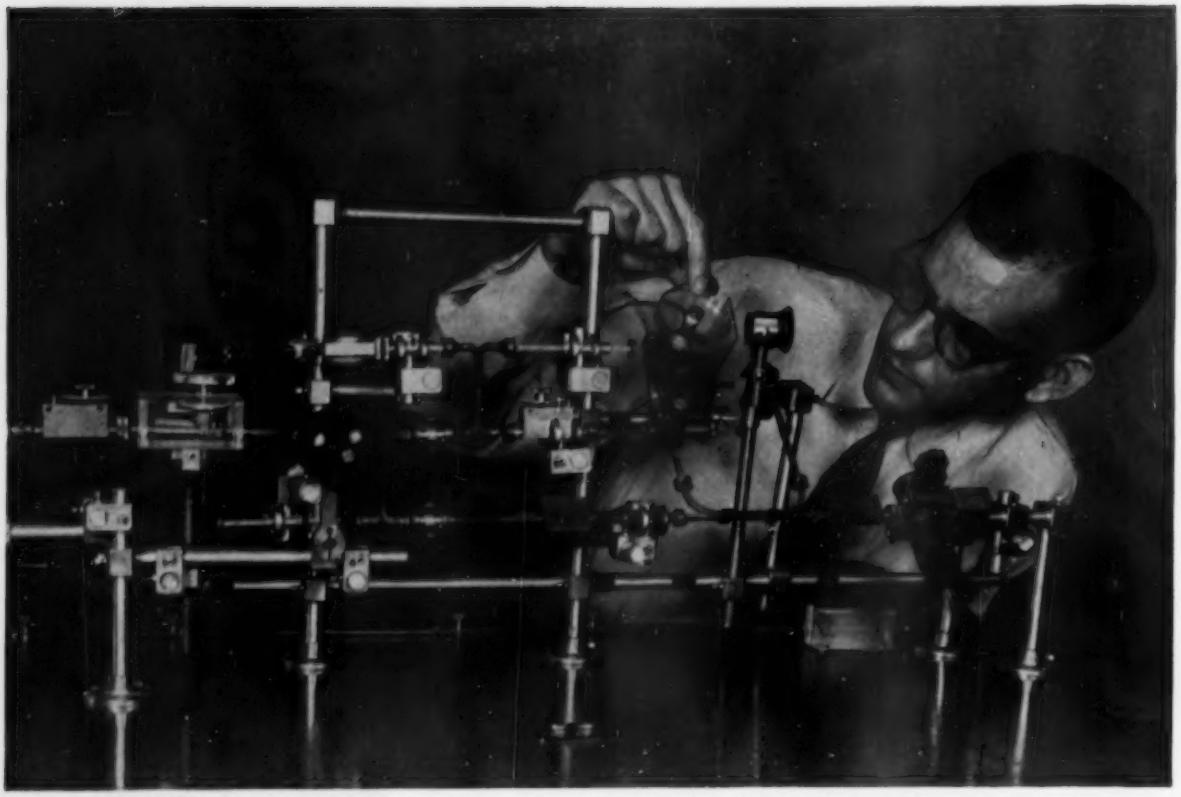


Physicist G. K. Farney checks the frequency of Bell's new klystron, which is located at far right. Tube's output is about 20 milliwatts.

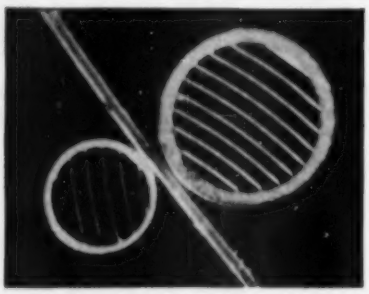
Sixty billion vibrations per second

A great new giant of communications—a waveguide system for carrying hundreds of thousands of voices at once, as well as television programs—is being investigated at Bell Telephone Laboratories.

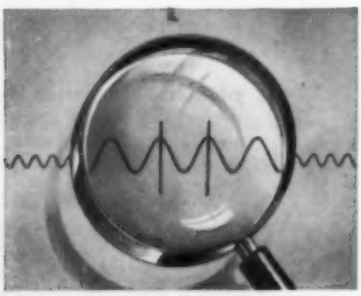
Such a revolutionary system calls for frequencies much higher than any now used in communications. These are provided by a reflex klystron tube that oscillates at 60,000 megacycles, and produces waves only 5 mm. long.

The resonant cavity that determines the frequency is smaller than a pinhead. The grid through which the energizing electron beam is projected is only seven times as wide as a human hair, and the grid "wires" are of tungsten ribbon 3/10,000 inch in width.

G. K. Farney, University of Kentucky Ph. D. in nuclear physics, is one of the men who successfully executed the development of the klystron. Dr. Farney is a member of a team of Bell scientists whose exciting goal is to harness the immense bandwidth that is available with millimeter waves . . . and to make certain that your telephone system remains the best in the world.



Grids in new tube, enlarged 30 times, with human hair for comparison. Electronic beam passes through smaller, then larger, grid.



Wavelengths produced by the klystron tube are only .2 inch long—1/15 that of the transcontinental radio relay system.

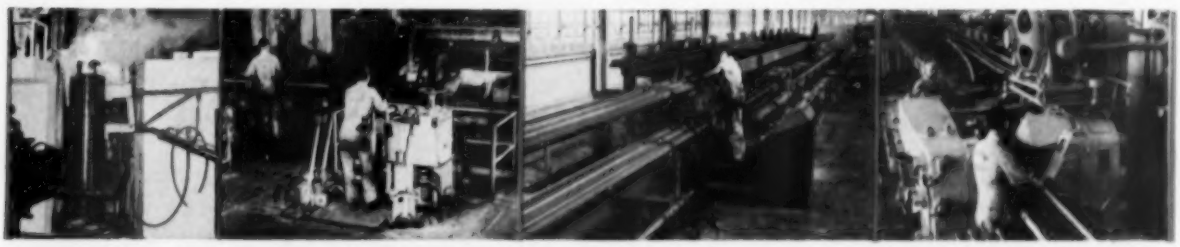
BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH

IS FOR QUALITY

. . . in rotating bands as well as other tubular products

If you use copper or gilding metal rotating bands—or if you require copper or aluminum tube or tubular products—Wolverine is the best bet as your "Number 1" supplier. The reason: quality! Here is an example of how we build in that quality:

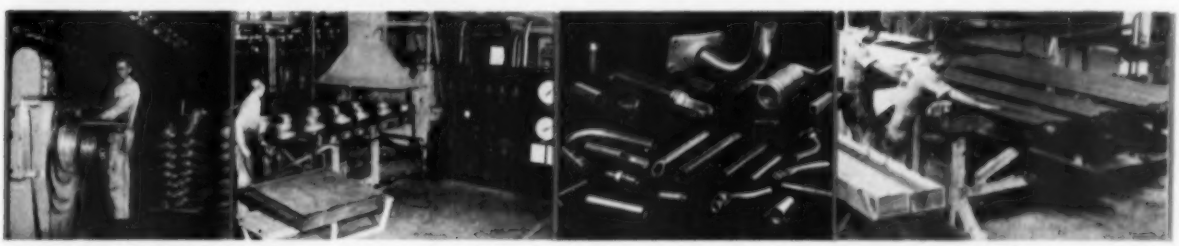


Raw copper is cast into billets and then sawed into extrusion blocks.

Pressure up to 2400 tons is available to extrude the pre-heated copper block into a base tube. (Piercing facilities are also available.)

Batteries of draw benches reduce the base tube to the diameter and wall thickness required.

Wolverine straight tube can be rolled on a flat surface without evidence of whip.



Some industries require tube in lengths too long to conveniently handle. For them, tubing is coiled.

When the tube is required soft for bending or other purposes, it is annealed in a controlled atmosphere furnace.

Fabrication—finning, bending, swaging, beading, flaring, spinning—are available upon special order.

Inspectors follow the tube through every step of the manufacturing process. This assures complete quality control . . . and that customer requirements are rigidly adhered to.

This is a synopsis of the story of the manufacture of copper and copper base alloy tube at Wolverine. The same careful attention to detail is followed in the production of aluminum tube and shapes. It adds up to one source for quality products . . . Wolverine Tube! WOLVERINE TUBE, 1499 Central Avenue, Detroit 9, Michigan.

Write today for the Wolverine General Products Catalog

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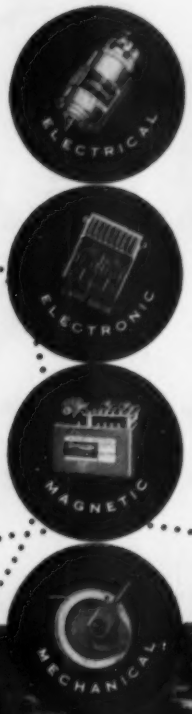

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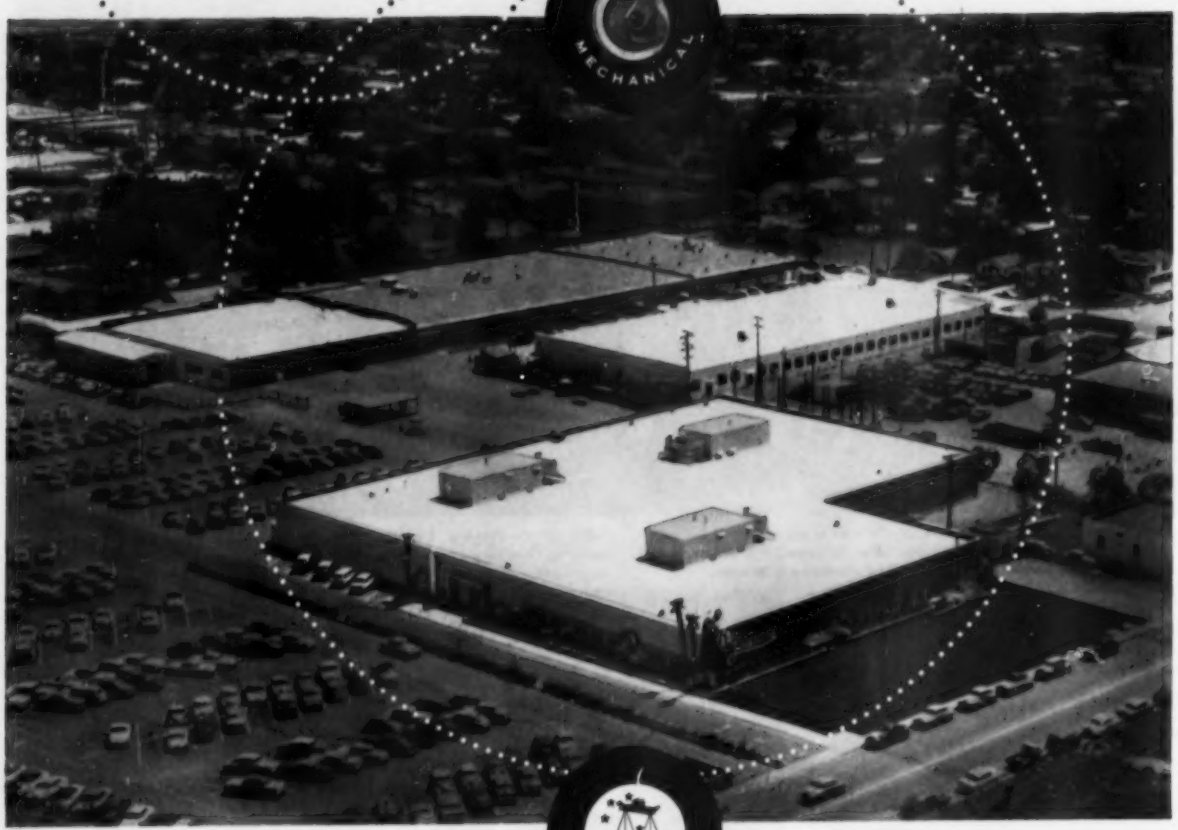

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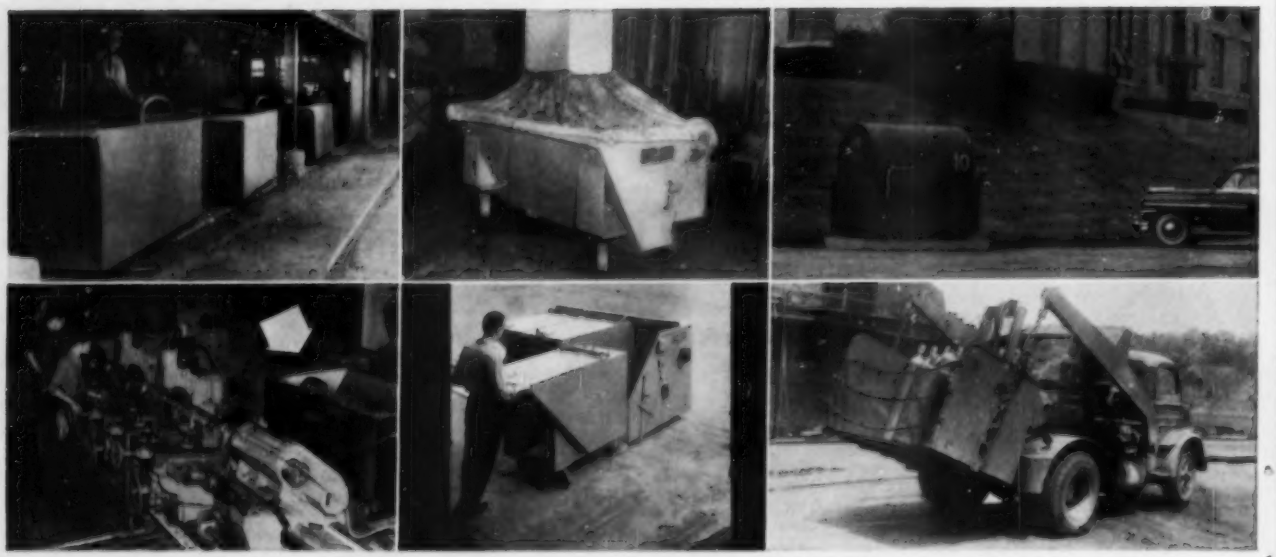

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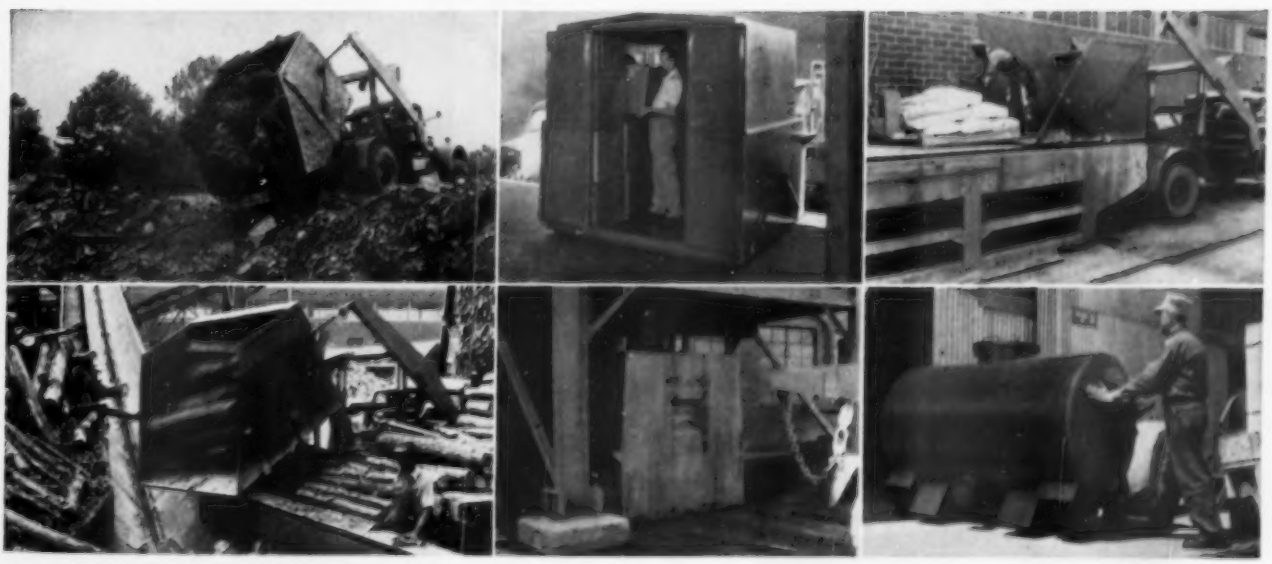

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Defense is everybody's business. Guided missiles like the Army's Nike are marvels of engineering skill, but they cannot operate without crews of trained personnel. All branches of the Armed Forces depend on young men and women who agree that "defense is everybody's business."

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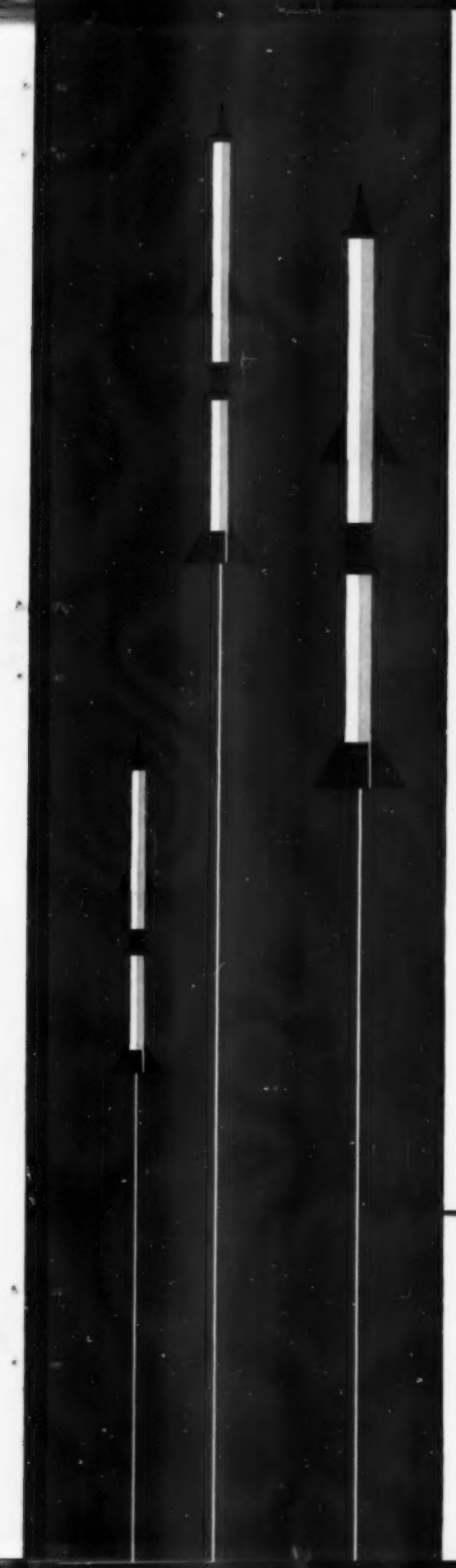

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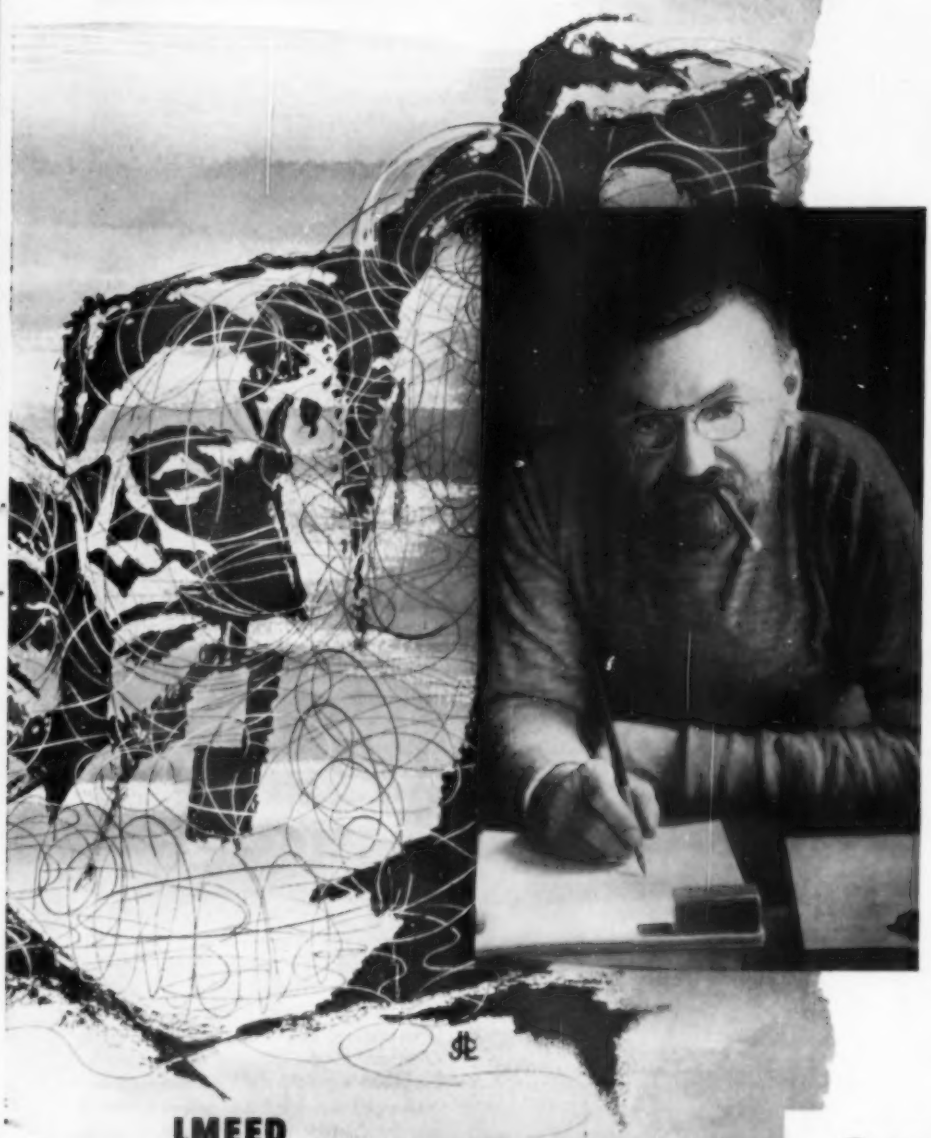

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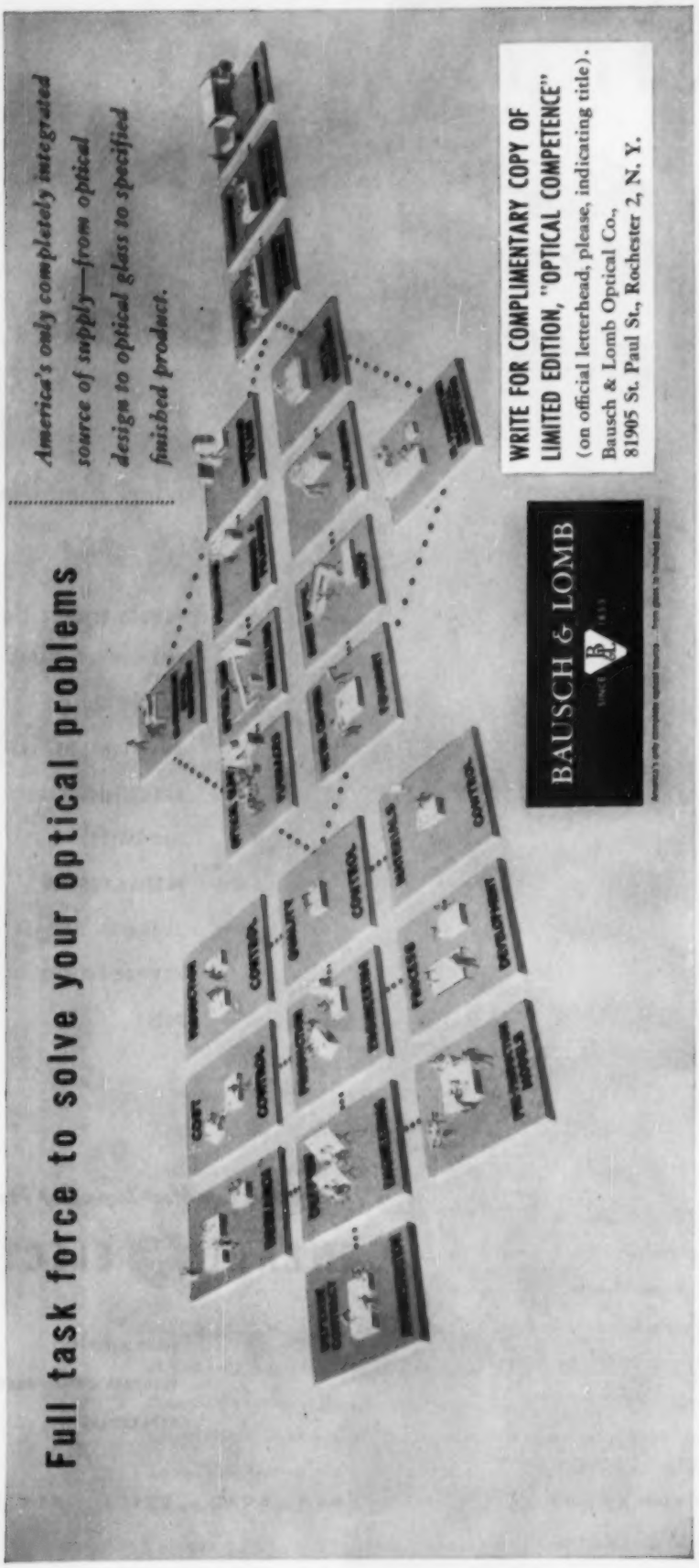
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ATOMIC ENERGY

URANIUM 235 RELEASED

President Eisenhower recently freed one billion dollars' worth of uranium 235 to be sold or leased "for peaceful uses" in the United States and friendly nations abroad. Uranium 235 is an atomic fuel, and when properly used in an atom reactor it yields great amounts of energy.

The 40,000 kilograms (88,000 pounds) of U-235 will be divided equally between the U. S. and foreign countries over a period of years.

The Soviet Union and its satellites are not included in the offer, nor are countries producing uranium 235, such as Canada and Great Britain.

ATOMIC POWER PLANTS

The General Electric Company and the Pacific Gas and Electric Company intend to build and operate an atomic power plant to serve the San Francisco Bay area. The plant, which will be located in the Livermore-Pleasanton area of Alameda County, Calif., will be financed entirely by private capital.

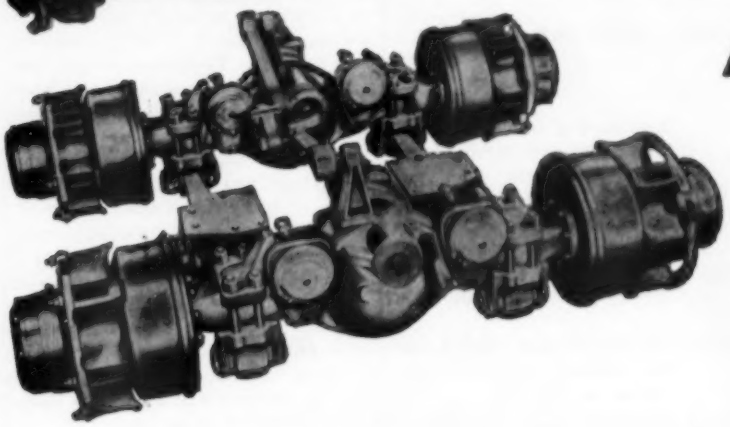
Plans call for completion of the plant during 1957 at a cost of between three and four million dollars. Initially the plant will have a maximum electrical-generating capacity of 5,000 kilowatts and an ultimate capacity of 10,000 kilowatts or more.

The General Electric and Pacific Gas and Electric Company plant will use a nuclear reactor of the boiling-water type. The experimental reactor facility will be constructed and operated at the General Electric Company's new atomic laboratory near Livermore.

The atomic power plant being built at Shippingport, Pa., by the Duquesne Light Company and Westinghouse Electric Corporation under the Commission's experimental power reactor program also is scheduled to be completed next year. It will provide homes and industries of the Pittsburgh area with 60,000 or more kilowatts of electricity.

A major atomic power plant project also is being undertaken jointly by Florida's three largest electric utility companies which are laying plans for the design, construction, and operation of a large-scale nuclear power plant.

The three companies—Florida Power & Light Company, Miami; Tampa Electric Company, Tampa; and Florida Power Corporation, St. Petersburg—have entered into an agreement with Allis-Chalmers Manufacturing Company and the Babcock & Wilcox Company looking to a target date of 1962-1963 for the con-



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This style container has many uses for both heavy and light parts.

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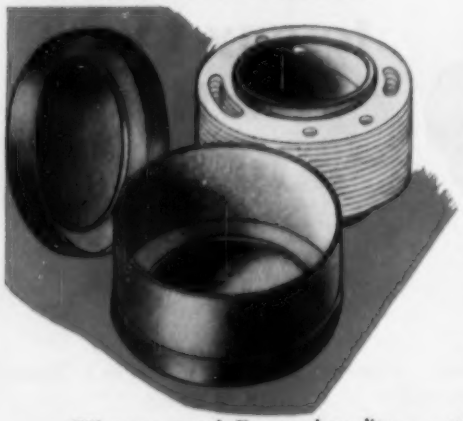

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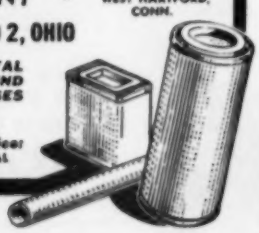

struction and operation of a major power plant using atomic energy for fuel, to be located at an appropriate site within suitable transmission distance of all three Florida companies.

The 3-company agreement looks to Babcock & Wilcox and Allis-Chalmers, also parties to the agreement, for technical know-how, design, and manufacture of the major equipment.

It is also contemplated that Stone & Webster Engineering Corporation will be associated with the project in connection with the plant's final layout and construction which will be subject to the approval of the Atomic Energy Commission and the Florida Railroad and Public Utilities Commission.

ISOTOPE DISTRIBUTION

Simplified procedures have been established for the domestic and foreign distribution of stable (nonradioactive) isotopes and rare earths produced by the U. S. Atomic Energy Commission.

Under the revised procedures, neither domestic nor foreign applicants will be required to file and obtain Commission approval of applications before purchasing the materials. Requests and purchase orders will be handled directly between the user and the AEC facility supplying the materials. Electromagnetically concentrated stable isotopes, previously available only on a loan basis, will be available for sale to domestic users. Reports of results of experiments using the materials will not be required from either U. S. or foreign applicants.

The Commission will establish annual or special quotas of the total quantity of each item to be distributed and the maximum amount which will be available to any one person, firm, or institution without special Commission approval. Samples of rare and expensive items may be loaned, provided they will not be diluted or contaminated during use.

NONMILITARY REACTOR

The first nonmilitary atomic energy reactor to produce power for the generation of electricity by a private utility will be the sodium graphite reactor now being built by the Atomics International Division of North American Aviation, Inc.

Negotiations are under way between Atomics International and the Southern California Edison Company for the "sale" of surplus heat from the reactor located in the Santa Susana Mountains about thirty miles northwest of Los Angeles.

The Atomic Energy Commission has authorized the two organizations to enter into an agreement for the electrical generation equipment addition to the reactor.

(Continued on p. 944)

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Atomic Energy (Cont'd.)

The sodium graphite pilot plant reactor will be completed this year. Producing 20,000 kilowatts of heat, the reactor is part of the AEC's 5-year program to develop economical electricity from atomic energy. Atomics International is contributing $2,500,000 to the reactor project in a joint participation program with the AEC for nuclear power development.

The new agreement, when finalized, will permit Southern California Edison to design, construct, and operate, at no cost to the Government, a heat exchanger and turbogenerator with an electrical capacity of about 7,500 kilowatts. Edison's investment in the electrical generating equipment will be over $1,000,000.

RESTRICTED DATA ACCESS

The AEC regulation under which business firms and individuals may gain access to restricted data relating to civilian uses of atomic energy is now in effect.

The new regulation defines the areas of secret restricted data to which access may be obtained. It contains a comprehensive list of categories of classified information available under the access program and provides that the applicant for secret restricted data relate his request to one or more of these categories.

This change will aid the applicant both by advising him of the areas of information available and by permitting him to refer in his request to specific categories. It will also facilitate interchange of secret restricted data between companies holding access permits for the same categories of information.

Information relating to the weapons program is excluded from all categories.

Included in the list of categories of restricted data available to access permit holders is information related to controlled thermonuclear processes.

In announcing the availability of information relating to controlled thermonuclear processes, the Commission emphasized that work in this field is still only in the very early experimental stage. The availability of such information under the access-permit program will, it is hoped, permit much wider independent experimentation and research, encourage more people to work in the field, and lead perhaps to earlier solution of some of the enormously difficult problems involved.

A change relating to patents is also made. In the proposed regulation the Commission generally waived its rights under Section 152 of the Atomic Energy Act of 1954 in inventions and discoveries resulting from access to restricted data but had retained an irrevocable, royalty-free, nonexclusive license for governmental purposes to inventions and discoveries resulting from access to secret restricted data. This proposed license provision has been eliminated.

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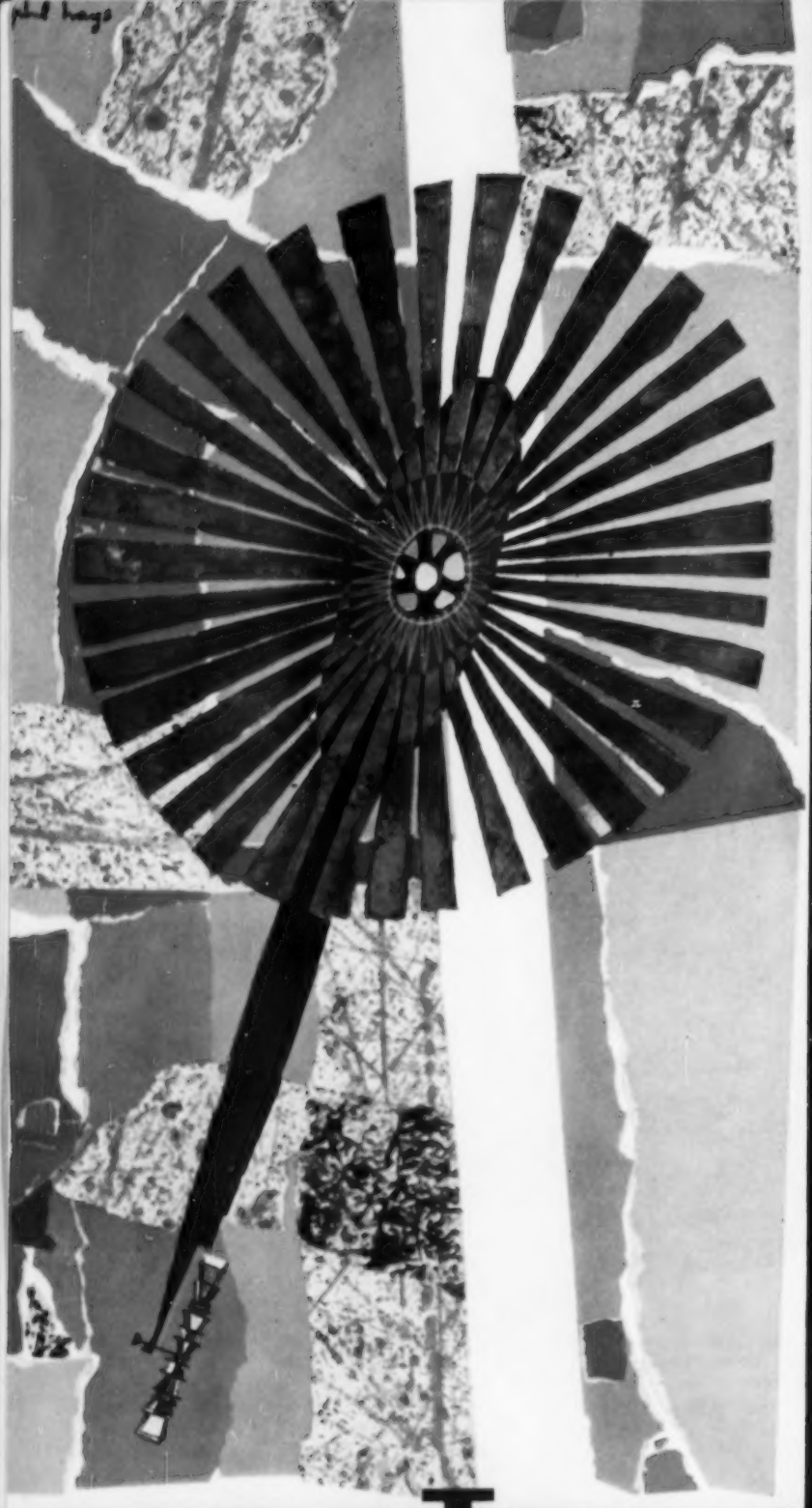

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Air Force Armament

MAJ. GEN. EDWARD P. MECHLING

Commander, Air Force Armament Center

Air Force Armament

The responsibility of the Air Research and Development Command

A LARGE segment of the vast domain of the United States Air Force is engaged in research and development. Its ten major research, development, and test centers throughout the country are guided and controlled from a vast nerve center—the Air Research and Development Command—presently located in Baltimore, Md.

This centralization of control was decided upon after several years of operation, during which each of the several agencies carried on its work independently. The United States Air Force's responsibility for achieving and maintaining qualitative superiority in America's air weapons sparked the ARDC into being as an integrated organization.

The mission of the ARDC embraces three essential responsibilities: (1) To attain and maintain qualitative superiority of matériel and to conduct or supervise required scientific and technical studies; (2) To seek new basic knowledge from which improved aëronautical equipment, matériel, weapons, and techniques can be developed; and (3) To undertake the development and recommend the adoption of appropriate new and improved devices and systems for the conduct and support of air warfare and aircraft missiles, including complete weapons systems, techniques, and procedures applicable to Air Force purposes.

TO these mission responsibilities the ARDC dedicates its effort. It coördinates the Nation's scientific talent to develop new and better equipment and contribute knowledge to defense-development problems. It uses its own facilities and those of some 200 universities and other nonprofit institutions and many industrial concerns to assist in advancing Air Force technology.

Maj. Gen. Edward Pont Mechling, United States Air Force, whose photograph appears on the opposite page, was commissioned as a second lieutenant of Cavalry upon his graduation from the United States Military Academy in June 1927. He was born in Knoxville, Tenn., September 13, 1904.

In 1929 he was detailed in the Ordnance Department, United States Army, graduating in 1932 from the Ordnance School and the Massachusetts Institute of Technology.

After ordnance duty with the Air Corps at Langley Field, Va., he was assigned as Ordnance Staff Officer, Eighth Air Force, European Theater of Operations, later as Assistant Chief of Staff, A-4. He also served in this capacity with the North African Strategic Air Force, and Headquarters, Fifteenth Air Force, Mediterranean Theater of Operations.

Upon his return to the United States he was assigned to G-4, War Department General Staff. In 1945, he was assigned as Chief Ordnance Officer, Headquarters, Army Ground Forces.

In 1947, General Mechling transferred to the United States Air Force and served in the Air Staff as Deputy Director of Armament, Office of the Deputy Chief of Staff, Matériel, from December 1948 to May 1951. In December 1951 he was assigned as Deputy Director of Armament, Headquarters, Air Research and Development Command.

On February 8, 1952, he assumed command of the Air Force Armament Center, Eglin Air Force Base, Fla., where he is serving at the present time.

General Mechling has been awarded the Legion of Merit, the Air Medal, and the Commendation Ribbon with two clusters. He is a member of Council of the American Ordnance Association.

A system of domestic and foreign field offices monitors research projects, maintains liaison with industry, and coördinates Air Force requirements with industry and the Air Force operational commands.

In the weapon-system principle of management the Command utilizes the research-development-production cycle, under which all components must be designed, integrated within a limited time period, tested as a whole, and produced at the lowest possible cost.

The testing of the weapon that precedes production, both of the many components as such and the assemblies of these components as integrated items, is the insurance of quality of the weapons used by the Air Force.

THE Air Force Armament Center at Eglin Air Force Base, Fla., tests aircraft armament systems and components, including guns, ammunition, bombs, and rockets. It also conducts research and development of test procedures.

This complete armament-testing facility has been created in the past five years, adding another name and place identified with our newest military service. The names of Sandy Hook, Aberdeen, and Dahlgren are now joined by Eglin, and, except for Sandy Hook, are the present armament testing facilities of the Army, Navy, and Air Force.

General Mechling has been connected with this very important testing facility since its inception. Under his command it has become an essential activity in the Air Research and Development complex and has achieved national recognition. Through forward planning it has programmed additional capability to test the air armament of the future. The basic experience General Mechling received from his Army Ordnance service, added to that he acquired with the Air Force, plus the talents available from the sister service testing centers has placed the Air Force Armament Center in a commanding position for "the present is intelligible only in the light of the past."

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the layman may ask, cannot a similar

sile employing the *ballistic* principle is

The Ballistic Missiles

Development of the Redstone with its range of 250 miles is but the forerunner of mightier weapons such as the Intermediate Range Ballistic Missile which will have a reach of about 1,500 miles

Mark S. Watson

IT is a gratifying thing to see that the full development of the Redstone missile, a mighty thing in itself and a herald of mightier weapons to come, has taken place at the Army's Redstone Arsenal, Huntsville, Ala. All the Redstone prototypes, which at this writing have been fired at all, have been made there on the spot.

Looking forward another stage—and a very large one it is—it is quite as gratifying to see that Redstone firings thus far have been for the purpose of advancing the development of a much more potent weapon, the Intermediate Range Ballistic Missile, not yet otherwise named, unless it be "Post-Redstone," and that the IRBM also will emerge from this same Army arsenal.

ULTIMATE use-production will be from a Chrysler installation, inasmuch as that corporation has the contracts not only for quantity production of the missile but also for the associated weapons system necessary for shipboard adaptation (storing, transporting, hoisting, launching, etc.). The Navy is associated with the Army in employing these new weapons which are capable of reaches vastly longer than any ballistic missile ever went before.

The circumstance that the two services are united in the development of this particular IRBM provides its own impressive evidence of their common confidence in a notable ordnance achievement.

Mr. Watson is a well-known military analyst and a member of the staff of the Baltimore Sun. *He is a holder of the 1945 Pulitzer Prize for international correspondence and a regular contributor to* ORDNANCE.

Further evidence, if needed, was supplied by the sudden shift in Defense Department policy a few weeks ago. Up to then, only the vaguest public references to Redstone had been made officially, with a studied refusal to endorse or deny even the widely circulated report that the new missile would have a range of roughly 250 miles. Suddenly there was official mention that, however good Redstone might be, there was something far more potent on the way in the form of the IRBM which would have a reach of 1,500 miles.

Redstone Arsenal itself (that is, parts of it) ceased to be inaccessible, and a number of unofficial visitors, including press representatives, were permitted to see the great 60-foot Redstone missile at close range, scrutinize the operations of transporting it, mounting it for launching, fueling it for flight, and making the firing contact.

They also were able to discuss with the arsenal's administrators and chief technologists numerous aspects of Redstone's design, construction, testing, and performance. Such articles as were written and such photographs as were made were, of course, subject to review before publication, but so well defined had been the discussions and so discreet the official spokesmen—notably Maj. Gen. John B. Medaris, commanding the newly created Army Ballistic Missile Agency, and Brig. Gen. H. N. Toftoy, commanding the arsenal and himself a distinguished pioneer in missiles and rocketry—that no excisions of importance were called for.

THAT, too, illustrates the departmental confidence that much of the development work now is past the secret stage and properly in the field of public knowledge.

An early suggestion of this had come late in 1955 when General Medaris was selected to head the new Army Ballistic Missile Agency—a first step toward the scheduled creation of a civilian Missiles Chief (directing missiles research and production for all the services) immediately under Defense Secretary Charles E. Wilson.

Pressed for an explanation of this new concentration of authority, Mr. Wilson indicated that there had been a "break-through" (whether in science or technology or both he did not say) of such proportions as to warrant a quick concentration of "doing" rather than further "advising" (of which he seemed to imply the Pentagon has a surplus).

There is no doubt that very large achievements lie ahead, but it is just as

that instant be precisely on the sched-

well to realize that the largest are still a considerable distance off, and by no means just around the traditional corner.

TIME may show that there has been more than one "break-through," but the sum of what has been achieved in the transition from the Redstone project to the IRBM project will do as a start. The former weapon is, by report, capable of traveling something like 250 miles; the other admittedly is expected to travel 1,500 miles.

That is so large a jump that one might conjecture that it marks a difference in kind rather than merely in degree. It is no great job to employ much of the design and many of the parts of a ½-ton truck in order to develop a ¾-ton truck; but if the manufacturer instead is after a 5-ton truck he has to make a completely new start.

It is somewhat surprising, then, to find that the principles of a 250-mile missile can be applied almost directly to a 1,500-mile missile. (Redstone is a one-stage rocket: one is advised that IRBM *could* be, too, although one cannot say with confidence that it *will* be.)

If that sixfold stretch can be achieved, the layman may ask, cannot a similar stretch be thought of, say, from a 1,500-mile to a 5,000-mile reach? It can be thought of all right, but officials apparrently do not think of it aloud in public, and here one finds himself in the midst of an extremely lively technological issue:

Do we develop the Intercontinental Ballistic Missile (of say, 5,000-mile range) from a wholly new point of departure, as has been unofficially discussed in the case of the Air Force's Atlas project? Or do we consider developing ICBM on a step-by-step basis, from Redstone to IRBM, and so on up to ICBM?

REDSTONE and IRBM we now know can "play in the same ball park" as a technologist says breezily. Is there room in that park for ICBM too? This is a question on which scientific as well as technological authorities have differed widely. It is just one of the numerous questions to which Mr. Wilson's new Missiles Chief must address himself.

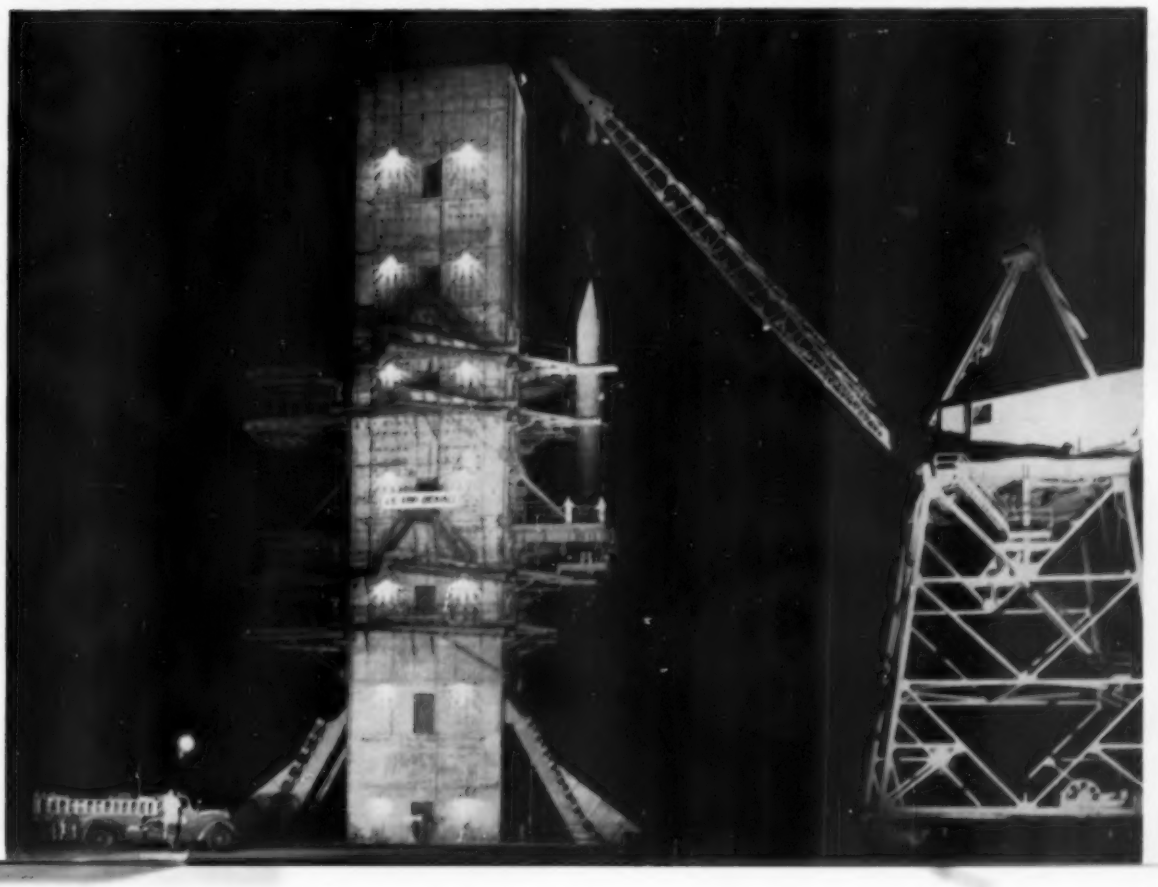
Another question, one dares ask, is whether the apparent break-through in the development of a 1,500-mile missile employing the *ballistic* principle is so mighty an achievement as to eclipse the enormously productive research which has been conducted on long-range *guided* missiles.

YET another question is whether elation over progress in rocket motors, the only presently working propulsion for missiles passing beyond the earth's atmosphere, is such as to cause a temporary minimizing of the ever-promising ramjet. That must be doubted, for the combination of ramjet, aided by rocket take-off, and continuous guidance has notable virtues which the ballistic rocket lacks.

For instance, it is true that the ballistic rocket now envisaged can be thought of as likely to attain a top speed in space of four miles a second, which obviously makes interception difficult.

But, with our present knowledge of materials' inability to withstand the heat friction developed at anything like that speed, once the missile makes its necessary return to earth's atmosphere on its approach to the target (the ultimately important part of its flight) it apparently will be necessary to slow

Tall as a 15-story building, the static test stand at Redstone Arsenal dwarfs the huge Redstone missile (Army photo).



idness as almost to persuade his hearers that they are looking at it, riding in it,

signed to the European theater during World War II, applied himself to scru-

as well, although this work hereafter is scheduled for the Ordnance plant at

An experimental aircraft rocket is fired on a ground track designed to test aërodynamic qualities of new missiles at Redstone Arsenal, Huntsville, Ala. (Army photo).

down that stupendous speed, whether by rockets firing toward the front, rather than the rear, or by wing controls, or by other braking devices.

WITH such a slowdown, obviously something of the difficulty of interception vanishes. The ramjet guided missile, being dependent upon air intake and hence limited to altitudes below 100,000 feet and being limited to a speed of perhaps one mile a second, is appreciably more vulnerable to interception on that account during most of its flight. The ballistic missile likewise will be more exposed to attack during the closing stage of the flight when, as noted, it will certainly have to be slowed down, and quite probably to something like the ramjet's own pace.

The positive virtue of the ramjet, of course, is that it is guided throughout its flight, whether from ground radar, or from a distant airplane, or by other devices so nearly magical that they are not to be discussed at this time. Thus if it be completely subject to this external guidance control, the ramjet will be able to pursue a weaving course and thus escape some of the vulnerability inseparable from the ballistic missile's direct course which can patently be calculated and conceivably blocked by intercepting missiles.

What is more significant, since the only really important stage of a missile's flight is its final arrival on target, if the ballistic missile's course over the last nine-tenths of its flight is finally and irreparably determined by its speed and its absolute direction in two dimensions at the conclusion of the first one-tenth (with the ten-times magnification of error which is involved) we must recognize the vast importance of the ramjet rival's continuous guidance, right down to impact.

Indeed, recognition of this is so inevitable that we must ask whether science and technology will not in time find a way of improving the ballistic missile by adding to it, in the closing stage, some power of swerving at need from its purely ballistic course in order to attain that last-minute precision which, obviously, is of incomparable value.

This would be something of a trick, certainly, but in view of the miracles which have already been achieved, who is sure that another is beyond the reach of man's mind?

OUR present concern, however, is with the ballistic missile development at Redstone Arsenal, and that is enough magic for the moment. What are the points of vast improvement of Redstone over Germany's wartime V-2, its early progenitor?

Guidance obviously is one, for the primary boast is that while Redstone's range is apparently not a great deal more than that of Germany's wartime V-2 the improvement in precision is tremendous, and that is all-important. If the missile gets its final launching early in its flight, patently it must at that instant be precisely on the scheduled course, both in azimuth and elevation. The velocity finally imparted by the expiring rocket also must be exactly known, for if it be greater or less than the calculation, the missile will reach beyond the target or fall short of it.

PROPULSION also has been improved. A look at the exterior of Redstone's fuel compartment, as compared with V-2's, discourages the suspicion that the greater range is achieved by a greater volume of fuel. Is it, then, a better fuel? Quite probably, for fuel chemists have been industrious these ten years.

Is the combustion method better, too? Almost certainly, yes, for here great progress was necessary and hence inevitable. The alcohol-plus fuel must be perfectly tested and proportioned, and the initial weight must be known exactly because this is the chief factor in total weight as well as the determinant of flight-limit.

The aërodynamic designer must also include in his calculations the fact that this immense weight is to be totally exhausted in a specific time, with obvious effect upon the missile's continuously changing balance while the fuel is being burned.

THE mention of these two obvious fields of immense research during the past decade, without regard to others, will suggest the scope of the work achieved at Redstone Arsenal. A very large amount of it was performed by Dr. Wernher von Braun and more than one hundred other German scientists and technologists.

Von Braun was the brightest spirit in the creation of Germany's V-2. His soaring mind carried him far beyond that leading terror of his day, not only to the semiperfection of the V-2 now visible in Redstone but to the extension of Redstone—first to the post-Redstone IRBM, then to a later ballistic development into ICBM, and much further.

Even the projected earth satellites which we are to launch next year are stepping stones in this contemplated series. The Armed Forces Staff College was lately enlightened by his extraordinary lecture on a later, manned spaceship, which he describes with such viv-

months behind schedule, until industry

enough to require an interesting device

idness as almost to persuade his hearers that they are looking at it, riding in it, and alternatively reconnoitering the entire surface of the globe, or dropping off a fully controlled winged bomb upon the spot where it might do a lot of good, or taking off in a rocket relay for the moon and back.

Von Braun, the chief scientific producer of V-2, is undeniably the chief producer of Redstone and, thus far, the principal in the march toward ICBM.

A word on the scientific-technological force at Redstone is in order. The 100-odd Germans who came here in late 1945 and thereafter, and to whom unstinted credit is due, have been joined by something like ten times that number of Americans, and a whole group of 9,000-odd Germans and Americans, military and civilian, have been fully integrated in the much larger Huntsville, Ala., community, well southwest of Chattanooga and midway between Birmingham and Nashville.

CERTAINLY Huntsville is changed from World War II days when this was a combination of ammunition-loading center and chemical base suddenly dropped next door to a charming old Alabama town in many respects little changed from the day when Cotton was King.

Nobody has seen more of the change, nor been a larger factor in it than General Toftoy. He was already interested in missiles before we knew of the V-2—when the National Academy of Sciences, in earnest search of surface-to-surface missiles, put the Ordnance Corps to work on a mere idea. It should not be forgotten that a first step was the creation of the wind tunnel at Aberdeen Proving Ground, first of its sort in the country and employed alike by Army, Navy, and Air Force as years went on until the other services could build their own.

IT was General Toftoy, an expert in rocketry, who maintained an interest in that science when others' interest flagged and under whose direction the Nike and Corporal systems were developed and the superbazooka and Honest John brought to reality.

Notably, it was he who, when assigned to the European theater during World War II, applied himself to scrutinizing all German ordnance installations within reach, recommended bringing to America the missiles staff at Peënemuende, himself rounded up the initial 130 German scientists, including Dr. von Braun, as they were moving away in groups toward refuge in Austria, and arranged for their trip to America.

GENERAL TOFTOY advanced from chief of the rocket branch of Ordnance Research and Development to director of the Redstone laboratories in 1952, and became commander of the arsenal in 1954, succeeding Brig. Gen. Thomas K. Vincent, when the latter retired to continue his outstanding career as staff consultant for Technical Divisions and Committees of the American Ordnance Association.

Much of wartime Redstone Arsenal survives today, not only the 40,000 acres of the big reservation which unites the old loading station (largest of World War II) and the chemical manufactory, but a good many of the original buildings which were vacated after 1945 when Government turnback of the property was seriously threatened.

Rescued and quickly chosen for missile use, these facilities have been vigorously worked, not only for the Army but also for the Navy and the Air Force, designing and loading Air Force rockets and the Falcon guided missile as well, although this work hereafter is scheduled for the Ordnance plant at Longhorn, Tex.

The most notable work for the Navy, of course, springs from the recent cooperation of the Navy with the Army on the Redstone missile and IRBM. The combination of ship mobility plus a 1,500-mile missile has such implications of long-range missions as to stir the imagination.

The arsenal itself has done a great deal to speed up missile production through a telescoping of engineering tests at White Sands, user tests (at Fort Bliss), modification, and standardization into the new, compressed "engineer-user" program, which gets the production manufacturer into practice earlier and, at some cost in dollars, saves much in time.

THE arsenal setup includes the Research and Development Division, the Industrial Division, and the Field Service Division, plus elements of a Training Division, directed from Aberdeen.

It must be remembered that the arsenal is not a large shop and is not considered a factory (actually the manufacturing contractor does 85 per cent of the work), but it is significant that this Army installation is as rounded an establishment as its great predecessors. It can machine, cast, mold (whether metals, plastics, or rubber) and develop components, which otherwise might be

In this time exposure of a night rocket flight, straight streak is missile path, sparks are propellant embers, arcs are star tracks around Polaris (Army photo).

months behind schedule, until industry is ready to take over.

This is the great function of the Ordnance arsenals as a whole. Not an industry in the country is capable of doing by itself a whole job of this sort. Also, once industry's invaluable service is enlisted, it still is not possible to turn it off and on like a faucet, for the main contractor's time lag is multiplied by the subcontractor's.

THESE appalling gaps the arsenal, in its own pioneering stage, can take care of with high efficiency—but only if Ordnance is allowed time to work out a program well in advance, and only if it can surely count on its money, instead of having it nipped off by sudden and unpredictable budgetary economies.

In Ordnance affairs, during the successive post-1945 "economy" waves, there were a good many changes of plan, but the planners did well to keep the German "recruits" well occupied, first at Fort Bliss and later at Redstone. Their families were brought over, their quarters and living arrangements provided, and their integration into American life effected in an orderly manner. They clearly are content, and America can afford to be highly contented with them.

IT was only last February that the Army Ballistic Missile Agency was created under General Medaris. It took over bodily part of the Ordnance Missile Laboratories of the Research and Development Division in the original Redstone establishment, as defined above.

The separation did not and does not interfere at all with the other research and rocket development under the arsenal and does not involve a duplication of the arsenal staff. Guided missiles had simply reached the point where separation was needed, so that there could be complete centralization on the most important of all the Arsenal's rocketry developments—the Redstone and IRBM enterprises.

General Medaris' new agency, while geographically enveloped in the old arsenal properties, is directly responsible to the Chief of Ordnance in Washington.

The new Redstone ballistic missile roars into the stratosphere during recent Ordnance Corps tests (Army photo).

The scene last February was impressive. On the day when outsiders were admitted, the great Redstone missile was on display at a convenient hardstand within the arsenal airfield, to which the 60-foot monster with its system auxiliaries had been swiftly and easily hauled up by tractor.

Near by was the tank truck from which the fuel is pumped into the empty chamber.

Near by, too, were the facilities and repair trucks, with compressor, batteries, and generators.

At a distance was the firing mechanism, connected by long electric cable with the combustion chamber and manned on this occasion by a youthful-looking German who eleven years ago had been doing much the same sort of thing with V-2's—and on occasion, he chuckled, diving into a slit-trench when the V-2 misbehaved. That apparently does not happen with the well-bred Redstone.

AT the other side of the reservation is the new testing-tower (the largest known) for testing motors, instrumentation, materials, heat, vibration, etc. It is a 150-foot concrete-and-steel structure with twin platforms for mounting the big missiles in initial static testing—not with full charge certainly, but with enough to require an interesting device for deflecting the tail blast.

This is a damlike structure immediately underneath the platform below the tail assembly. Over the dam pours a sheet of water into a pool where the blast of flame is cooled down a matter of yards from the tower's numerous intricate testing devices and the technologists on duty there. It is a costly business, and it took the Ordnance Corps quite a time to get the need for it properly recognized.

While it was still on the way the German researchers did the best with what they had—they built a single, small makeshift tower out of scrap metal they salvaged around the arsenal.

NOT too far distant in the outdoor testing area is a ballistic track (looking much like a wrong-way toboggan slide) where the small-sized prototype rockets get their tryouts. They are first mounted at an appropriate angle on a sort of sled, moored at the base of the inclined ballistic track. The sled itself is propelled by take-off rocket from a standing start to supersonic speed in the course of its swift whiz up the track. At a designated point the main rocket is fired, and the real testing measurements begin.

The visitor is not quite prepared for such a flash of lightning. On the day referred to, a self-assured newspaper photographer set up his camera to get what looked like an easy and photogenic shot. The warning signals were called off by seconds "Four! Three! Two! One! Zero!" and then came "BANG!" Every eye winked, and in that instant of a wink the show began and ended!

It is unfortunate that at the moment it is not permitted to speak in more precise terms of the great new missile's proved performance. Much more will be said soon, one gathers, under the new Defense policy of releasing additional technical data in quantity, now that we are reaching into the production stage with so many missiles of so many patterns, for so many purposes. At the moment, the clear prospect for the intermediate range ballistic missile is about the brightest spot on the Ordnance horizon.

Industry and the Reserve

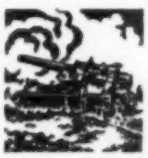
The success of the Reserve Forces Act of 1955 depends upon the help, the active support, and the understanding of industry in assisting young men to implement their training obligations

Charles C. Finucane

Under Secretary of the Army, Washington, D. C.

AMERICAN industry has a proud history of magnificent response to its country's call in time of war. American industrial know-how and production skill have been a nemesis to our enemies and the cornerstone of the success achieved in battle by our armed forces. But now, for the first time, industry faces a manpower call in time of peace—a call of the Reserve Forces Act of 1955—a call which will affect almost every employer.

In brief, the Reserve Forces Act, or RFA, does this: It spells out for our young men their military Reserve obligations, which are now compulsory. It's an American answer to the problem of national defense without a large standing army. The RFA, at the same time, enables industry to know exactly where it stands in regard to its personnel involved in the program. It makes for employee stability, which is a most important consideration.



The success of our Reserve program is essential to national security. *It cannot succeed without the help, the active support, and the understanding of industry.* I cannot emphasize this point too strongly.

We are living in an age of "time compression"—a condition brought upon us by instantaneous electronic communication and supersonic speeds. This time compression means that in the event of a national emergency, days—or even hours—will count more than weeks did in our past conflicts. The luxury of time in which to prepare will never again be ours.

Time compression, then, has disabused us of the concept of the untrained Minuteman. Today, with modern warfare pitched to atomic weapons, guided missiles, and airlifted tactical units, the nation satisfied with semi-preparedness is courting oblivion.

We don't need nor want a large standing force-in-being, but we must have well-trained, well-organized, and well-equipped units available for the call of the Commander in Chief and the Congress.

The RFA is the answer—it will give that vital element of depth to the existing defense forces of our country.

The Reserve Forces Act, which became law last August, combines amendments to the 1952 Armed Forces Reserve Act and the amended and maligned 1951 Universal Military Training and Service Act, making changes in both laws. It provides for an organizational structure consisting of the Ready, Stand-by, and Retired Reserves, the same setup as under the old bills.

However, the authorized strength of the Ready Reserve for all services has been raised from 1,500,000 men to 2,900,000 men. Excluded from this total until July 1, 1957, are all persons who have an obligation on the date of enactment of the act who are not actively participating. The Army's portion of this Ready Reserve is established at 1,692,000.

THE new law gives the President the power to call Reservists to active duty without the authority of Congress. In an emergency declared by the President, he can call up to 1,000,000 members of the Ready Reserve to active duty. Men in the Stand-by Reserve can be called only in time of war or emergency declared by Congress.

The question of whether a Reservist is in the Ready or Stand-by Reserve, therefore, is of importance both to the individual and his employer. Here are the significant portions of the RFA:

1. All men, up to age 26, entering active service after August 9, 1955, via draft, enlistment or commission, have a 6-year military-duty obligation. If they spend two years on full-time active duty, as many will, they then must also serve three years in the Ready Reserve plus one year in the Stand-by Reserve. Ready Reserve training consists of forty-eight weekly classes (usually a 2-hour session) plus two weeks of field training, being paid according to rank.

In some cases, as determined by the requirements of the service, the individual may be required to perform thirty days of annual training in lieu of the

trialist a chance to implement a satis-

forty-eight weekly classes and two weeks of field duty. A man enlisting for three years of active duty must put in an additional two years in the Ready Reserve and one year in the Stand-by Reserve. Four-year enlistments are to be followed by one year with the Ready Reserve and one year with the Stand-by Reserve.

2. Young men, aged 17 to 18½, up to a yearly Army quota of 100,000, have a choice of enlisting for a draft-deferred 8-year period on the basis of full-time active service for 6 months to be followed by 7½ years in the Ready Reserve. While on active duty, these young men receive a pay of $50 monthly—this figure will be raised to $78 if Defense-pushed legislation gets congressional approval. In addition, if a student is doing well in high school, his active service may be deferred until after graduation but not after the age of 20.

3. Personnel who had been on active duty prior to enactment of the new law, and those now on active duty, after having completed two or more years of active service will continue to be in the Ready Reserve for eight years (less years of active service). However, in their cases training is voluntary, and three years of Ready Reserve training qualifies this group for transfer to the Stand-by Reserve.

In addition, those men who complete their active duty between August 9, 1955, and July 1, 1957, may enlist for a year's training with the Ready Reserve. They will then have no further Ready Reserve training obligation but will be transferred to the Stand-by Reserve.

Men graduating under the Reserve Officers' Training Corps program will continue to get Reserve commissions and are subject to two years of active duty and three years in the Ready Reserve. If such officers are not needed on active service, they will be ordered to duty for 6 months of training and then serve 7½ years in the Ready Reserve. They will be encouraged to continue participation in the Reserve program after their obligation is satisfied.

COGNIZANT of the well-publicized shortages in the scientific, engineering, electronic, and other critical manpower categories necessary to the maintenance of our technological supremacy, the Department of Defense has instituted the "six months' critical skill program" to complete the Reserve Forces Act (see list on page 955).

Under the provisions of the program, put into effect only recently, persons with certain skills who are employed in defense-supporting industries or research may enlist in the Reserves for a period of eight years. They serve on active duty for six months and fulfill the remainder of their obligations in the Reserve.

Industries designated as critical have been carefully defined. They include the production of aircraft, ordnance and missiles, electronics and communications equipment, health and welfare services, educational services, research and development services, and others.

To make the RFA of 1955 fully effective, teeth have been put in the measure in this fashion: If a Reservist fails to perform his duties satisfactorily in any year, he may be ordered up involuntarily for 45 days of active-duty training. Failure to comply with such orders could result in court-martial proceedings.

This, in essence, is the extent of the RFA as it effects the young men of our Nation. Now let us discuss its effect on industry—on the employer or the one concerned with management or production.

You may ask why industry should support a Reserve program which would train men who may have to be called to the colors in time of emergency, a time when an employer might need these men as never before. It is a fair question and one which provoked a good deal of thought in the drafting of Reserve legislation.

THE Reserve Forces Act of 1955 specifically protects the employer in this respect. A continuous screening process will place the truly essential workers in the Stand-by Reserve, a group which would not be called for duty in the initial stages of a crisis. Under this plan, the men who may be considered more valuable to industry than to the military can be transferred from the vulnerable Ready Reserve into a Stand-by classification. Then the only way the armed services may call them to duty would be through the offices of the Selective Service system.

Then, too, younger employees, those who probably have not been on the rolls long enough to be considered thoroughly skilled in an industry, would be the ones subject to the first call, and this group might be of sufficient strength to satisfy military requirements. Manpower planners anticipate that the time lag in calling up the Stand-by Reservists, if they are needed, will give the indus-

Valuable training practice is acquired by Reservists in simulated battle problems conducted during the required yearly active duty (Army photo).

trialist a chance to implement a satisfactory program of substitution.

Further—and this is a cardinal point—as more young men join the Reserve program, business not only receives the protection of numbers but also has a chance to train their employees uninterruptedly. And remember that this is not a one-shot program—it is designed for use in many years to come—for as long as there is a threat to our way of life.

THE United States Chamber of Commerce was one of the important industry groups supporting the Act. Boyd Campbell, president of the U.S.C.C., in an article written for the *Army Information Digest,* discussed the need for such measure and made a number of cogent observations concerning industry's responsibility in fully implementing the act.

"Until August 9 (of 1955)" Mr. Campbell writes, "Reserve training was a voluntary matter and relatively few Reservists chose to participate. As a result, only a small percentage of companies with large numbers of Reservists on their payrolls felt it was necessary to adopt special policies regarding military leave and related subjects. Those that did were quite liberal in their policies affecting Reservists.

"The prevailing practice among firms having such policies is to grant Reservists fifteen days or two weeks of military leave in addition to vacation time. In most instances, Reservists draw no salaries—other than their military pay and allowances—while on military leave, but receive full credit for seniority and other employee benefits."

Mr. Campbell explains that, because of the new Reserve Forces Act, it is inevitable that more and more young men will be participating in Reserve training. This will raise many questions regarding schedule adjustments to attend weekly drills, extra time off, with or without pay, to take part in field training exercises, and others too numerous to list.

In anticipation of these questions, as well as union demands for specific contract clauses to "protect" workers affected by the new law, most employers who already have special Reservist policies are reviewing them to determine their adequacy. Many other employers are considering the adoption of such policies for the first time.

"I am confident," Mr. Campbell concludes "that American businessmen everywhere will recognize not only the value of the law but also the moral obligation that it imposes upon them to make it as easy as possible for Reservists on their payroll to discharge their training obligations."

Labor, of course, also has taken a keen interest in the RFA, and before their recent merger both the AFL and the CIO were preparing clauses for new contracts with industry which would protect their members rights while fulfilling their Reserve commitments.

Many knotty problems involving industry and the RFA will have to be worked out. For instance night workers, overseas employees and traveling salesmen are still obligated to participate in training, yet the nature of their jobs might make it impossible for them to accomplish this during normal evening drill periods. Pittsburgh Reserve units, with a large proportion of night-work Reservists on their rosters, have already undertaken provisions for daytime training.

The law provides that a Reservist who is prevented by distance, geography, or occupation from taking training will have a variety of opportunities for performing his obligation. In the case of traveling salesmen, the Ford Motor Company for instance has a policy which states "the company attempts wherever possible to arrange traveling schedules so that employees may attend necessary training sessions." The provisions in the act which enable Reservists to complete their entire obligations by a 30-day tour of active duty helps those men engaged in work of a seasonal nature.

IN addition to showing an employer exactly how he stands on the important manpower, the RFA can provide for industry many collateral benefits. The National Manpower Council, in its thorough and provocative study "A Policy for Skilled Manpower," recognized a number of these points. In discussing the employer appraisal of workers, the Council noted:

"When hiring young workers for positions below the professional level, they (employers) are far more concerned with general qualifications than with specific aptitudes or skills. Proper attitudes, general intelligence, and good ability in reading, writing, speaking, and arithmetic are valued far above specific training."

The Council agreed that employers placed as much emphasis on attitude,

Chemist*	Orthopedic Appliance and Limb Technician
Clinical Psychologist	Osteopath
Die Setter	Parasitologist (plant or animal)
Engineer Draftsman	Patternmaker
Engineer Professional (all branches)	Pharmacologist*
Foreman (critical occupations only)	Physiologist (medical)*
Geologist	Teacher, College and Vocational (critical occupations only)
Geophysicist	Physicist*
Glass Blower, Laboratory Apparatus	Teacher, High School (mathematics and physical and biological sciences only)
Jig-and-Template Maker	Tool and Die Designer
Mathematician*	Tool and Die Maker
Microbiologist* (includes bacteriologist)	
Nurse, Professional	

* Limited to those having graduate degrees (master's or doctor's) or equivalent experience, education and training (generally considered not less than 1 year beyond bachelor degree level).

Manpower categories necessary to the maintenance of technological supremacy.

and here service in the Armed Forces and regular training in the Reserves would play an important rôle. Active duty in the military often works wonders with the attitudes of our young men, enables them to understand the values of a career, and teaches them to accept responsibility on a scale unparalleled in industry.

As for the specific skills which the armed forces can teach our youth, the Council reports:

"The elaborate training offered by the armed forces opens up areas of training and work experience to many who, in civilian life, would be barred from such training because of discriminatory practices. . . . A study made in 1952 by the University of Minnesota found that one veteran out of five was making at least some use of his military training in civilian work.

Many States are throwing their full weight behind Reserve training with the passage of legislation protecting the benefits of Reservists. The Iowa legislature, for one, recently passed a bill imposing a fine not to exceed $100 or imprisonment in the county jail for a period not to exceed 30 days, of any person, firm or corporation discriminating against any officer or enlisted man of the National Guard or Reserve.

The law states in part that no employer or agent of any employer shall discharge any person from employment because of being an officer or enlisted man of the military forces of the State, or hinder or prevent him from performing any military service he may be called upon to perform by proper authority.

IN Iowa, any member of the National Guard or Reserves of the armed forces of the United States ordered to temporary active duty for the purpose of military training, or ordered on active State service, is entitled to a leave of absence from his permanent job during the period of such duty or service. Upon completion of duty, the employer must restore him to the same or equal position he had held prior to such leave of absence, provided, however, that the Reservist or Guardsman can give evidence to the employer of satisfactory completion of training or duty, and further provided that he is still qualified to perform the duties of his position.

Iowa law construes these service periods as an absence with leave and they in no way affect the employee's rights to vacation, sick leave, bonus, or other employment benefits relating to his particular employment.

Utah, too, recently passed a bill of similar nature, permitting all Reservists employed by the State or any county or municipality to have up to fifteen days military leave each year with full pay for summer encampment or rifle competition matches, in addition to their paid annual vacation. Reserve leaders in Utah are now attempting to persuade industry in Utah that it is to their advantage to follow suit.

Another state to pass such legislation is Delaware, whose measure authorizes any member of a Ready Reserve unit to a leave of absence not exceeding fifteen days a year for the purpose of receiving military training. Each Reservist is required to provide his employer with 90 days' notice of the dates of departure and return. If he satisfactorily completes his military training, the law requires that he be restored to his job with the same status, pay and seniority.

Another provision of the law ensures that the Reservist's absence shall not affect his right to receive normal vacation, sick leave, bonus, advancement, and other advantages of his employment.

Should the employer fail to comply with any of the provisions of the law, the Reservist-employee is entitled to bring legal action for damages or noncompliance, to apply to the Superior Court for recourse. The employer is not required to pay the employee during his military leave.

Wisconsin, too, has been quick to pick up the trend, although not by legislation. More than 400 of Wisconsin's largest industrial firms have endorsed a policy of liberal leave, including pay differential between civilian and military remuneration. Other states and industrial groups are following suit throughout the Nation.

Rilea W. Doe, civic-minded vice-president of Safeway Grocery Stores, Inc., advises:

"We can help our Department of Defense by giving our employees who are in the Reserves their required two weeks in summer camp at full pay. Some companies think they should be allowed their regular vacation time too. It is either support Reservists this way or else the Defense Department must keep more men in uniform all the time. If we are to be defended, our men must have advance training."

Mr. Doe's statement, I think, is the pure essence of the reason for a strong Reserve program.

IN addition to the intangible rewards of the RFA of 1955, such as the stabilization of manpower requirements and the eventual savings to the Nation as a whole as a result of reduced costs of maintaining a huge standing Army, the Secretary of Defense has authorized that a citation certificate and pennant be awarded to those organizations which have rendered outstanding coöperation in their official policies toward Reservists and toward Reserve activities.

Any employer, company, or business, regardless of size, or the number of Reservists employed, may receive the award if certain standards are met, such as: providing leave, in addition to regular leave, for annual Reserve tours of duty or emergency duty with pay, or with the difference in pay between military and organization; personnel policies and procedures, including hiring, promotion, or transfer of Reservists without discrimination; assistance to Reservists in making scheduled training; and a demonstrated interest in Reserve activities.

The Reserve Forces Act, combined with the rôle it will play in our national defense, is in effect, a two-way street. It provides definite benefits for industry and must in turn receive the help and support of industry to provide maximum effectiveness.

American employers hold the key to its over-all success. It is a challenge and a call which I believe American industry will answer in the wartime tradition of wholehearted coöperation.

New Guided Missiles

Shown above is the first official photograph of the Air Force's Northrop SM-62 Snark long-range strategic missile undergoing tests at the Air Force Missile Test Center, Fla. Below is the Martin TM-61B, a new version of the Matador tactical guided missile. It has a longer nose section, a new airborne guidance system, and is rocket-launched from a mobile semitrailer.

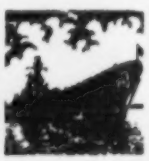
What's New Under the Sea

Nuclear power for propulsion combined with advanced hull designs will result in high-speed, long-range submarines capable of firing atomic torpedoes or guided missiles against many targets

Lieut. Comdr. Jon L. Boyes

IT was in 1955 that quiet-spoken Dennis Wilkinson, commanding officer of the U. S. Submarine NAUTILUS, released the historic message, "Underway on nuclear power." In the first year of her operation, this amazing ship with the nuclear heart has traveled 26,231 miles without refueling, and 13,141 of those were submerged. On one trip alone, NAUTILUS logged some 1,300 miles submerged, steaming at better than 16 knots on her atomic plant.

The nuclear reactor is the heat generator of the NAUTILUS engineering system. The fuel (uranium) contained in the reactor core gives off a tremendous amount of heat by fission. No oxygen is required in this process. Distilled water, under pressure, is converted to steam in the reactor heat exchanger. Steam turbines drive the NAUTILUS.



Remotely controlled electric systems carefully regulate the rate of heat emission in the reactor core. Unique instruments assist the engineering personnel in their jobs. One of these is the neutron counter which keeps track of the core neutrons. Deadly radiation from the reactor itself is sealed off by thick shields. Working personnel receive, under normal conditions, a much smaller dosage than given off in a chest X-ray.

Until the development of the NAUTILUS, submarines were driven by means of a Diesel-electric system, rugged, easy to repair, and reliable. Hand power, steam from coal-fed furnace boilers, gasoline engines, and carbonic gas power had been tried as propellants, and all had been rejected.

Commander Boyes is commanding officer of the U.S.S. ALBACORE, *the first hydrodynamic research submarine.*

The Walter closed-cycle turbine was hailed as the answer to the never-ending search for the perfect submarine system. The hope was short-lived. The difficulties involved in handling the explosive hydrogen peroxide fuel and the high costs of the fuel and the propulsion system outweighed the advantages of the Walter engine. Hydrogen peroxide fuel for submarines is still an active project in the British Navy. Electricity maintained top position as the best underwater power source.

The submarine was destined to continue in the rôle of a surface ship capable of diving as long as battery power was used. There is small wonder that submarine designers planned their ships to include good surface stability and sea-keeping qualities. Even with snorkel breathing tubes, the submarine hull was still designed for surface cruising. Experience had shown that there were times when "snorting" was not possible.

In 1943, appalled by the ever-increasing losses of their submarines, the German Admiralty decided to get their submarines off the surface by breaking away from certain conventional submarine concepts. Guided by new directives, German naval architects began a plan for a submarine with increased underwater speed and performance but with less surface capability.

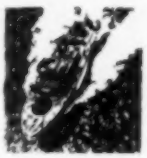
TEUTONIC skill and ingenuity completed plans for the Type XXI submarine in less than three months. The finished product exceeded the designers' expectations as it darted and banked at 16 knots to depths previously untouched by other submarines. Sixteen knots was almost twice the underwater speed of other submersibles.

The XXI boat showed that a hull form designed primarily for underwater flight could better utilize the available thrust of its propulsion system than could the conventional submarine hull.

A ship, operating in the air-water interface or completely in water, creates various retarding forces equal and opposite to the propelling force at constant speed. In so far as the submarine hull is concerned, two resisting influences waste the thrust power of the motors—frictional resistance and form (eddy) resistance.

The first is the resistance of the water past the wetted surface area of

the body; the second, the energy absorbed in the forming of eddies at the after portions of the appendages and in the ship's wake. The problem of the naval architect is to reduce these effects to the minimum through a careful design of the hull form and its appendages.



A look at geometric forms which are least affected by these two resistances is contradictory. The sphere, for a given volume, has the least frictional resistance. Unfortunately, large eddies develop in its wake. The needle, though least affected by eddy drag, has little useful volume because of its dimensions.

However, if these two shapes are melded, the resulting teardrop form will have the minimum possible power loss due to resistance. Final selection and drafting of the proper tear shape for the submarine of the future will be a compromise among ship resistance, desired dimensions, available materials, armament, and operational requirements.

WHILE the symmetrical body of revolution, the tear, has a certain degree of equilibrium, the designer improves it with ballasting and stabilizers. Simply stated, submarine directional stability is the submarine's ability, when in neutral trim, to fly hands-off with any oscillations of pitch gradually dampening out.

Early submariners did not always appreciate the need for directional stability in their ships. Alan Burgoyne's book, "Submarine Navigation," describes the 1887 sea trials of the Turkish submarine ABDUL HAMID:

"Nothing could be imagined more unstable than this Turkish boat. The moment she left the horizontal position the water in her boiler and the banks surged forward or backward and increased the angle of inclination. She perpetually rocked up and down like a scale beam. Once, and we believe only once, she fired a torpedo, with the result that she, as nearly as possible, stood up vertically on her tail and proceeded to plunge to the bottom, stern first."

Good stability and manueverability are musts for the future high-speed submarine if it is to be driven up quickly from the bottom to near-surface depth, level off smartly, fire its weapons, and then glide back into the depths.

In addition to enhancing the stability of the submarine, the tail stabilizer and attached diving planes give the ship controllability. The stabilizer acts like the tail feathers of an arrow and tends to hold the vessel in a straight path. Movements of the planes cause a change in the flow forces and the ship's axis is directed accordingly. Forward diving planes are added to assist in changing the angle of inclination, to help trim the ship, and to accelerate the rate of change of pitch.

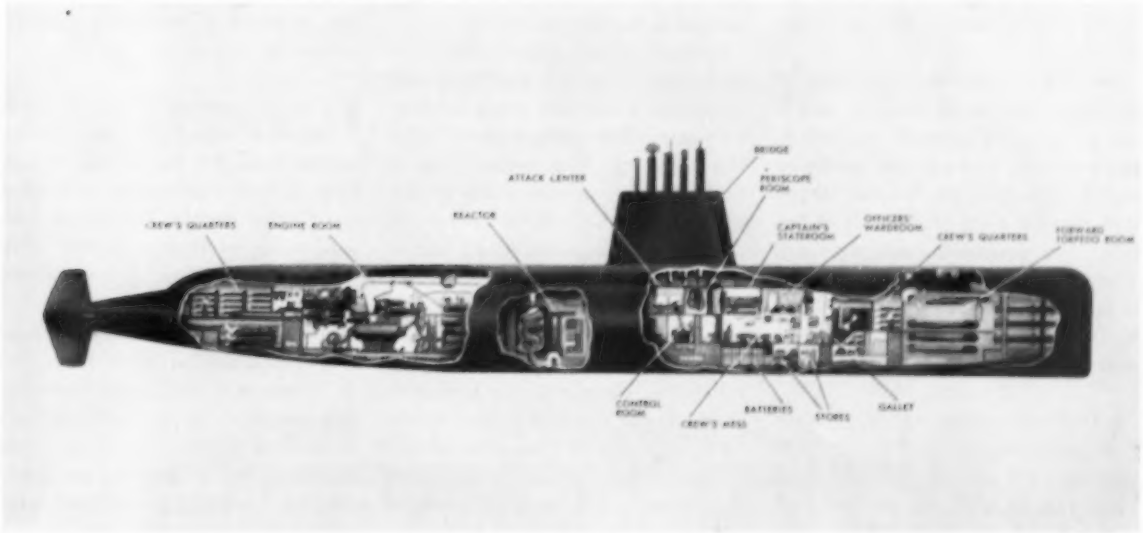
From experiences in World War II and from the knowledge of the German Type XXI submarine, the United States Navy began research toward finding the ultimate, efficient, and controllable underwater hull form. Previous empirical data and theories were carefully reviewed.

A SPECIAL naval development committee, under the chairmanship of Dr. Davidson, director of the Experimental Towing Tank at Stevens Institute, Hoboken, N. J., began a series of hydrodynamic studies with the above objectives in mind in the late 1940's. David Taylor Model Basin, in conjunction with this group, started a design series to establish the best underwater hull form. A series of models was built—ranging in length from seven feet to twenty-five feet. From these tests, the best form was chosen. Two new models were then constructed—one a single-screw ship, the other with twin screws.

Additional tests were conducted by the National Advisory Committee for Aëronautics at the Langley Aëronautical Laboratory, Langley Air Force Base, Va. Models were placed in a wind tunnel and studied for drag and lift characteristics.

On November 24, 1950, the Navy authorized the construction of its first

Cross section drawing of the NAUTILUS shows the compact interior design of the world's first atomic-powered sub.



Most of the work being done by At-

they hand gesture their hydrobatics and

The radical new "teardrop" design of the ALBACORE gives it the appearance of an enormous shark when surfaced (Navy photo).

hydrodynamic research submarine. Two years later the detailed design and hull were completed at the Portsmouth Naval Shipyard, Portsmouth, N. H. Her name, ALBACORE, was apt indeed.

ALBACORE is an unimpressive looking submarine. She is small, potbellied, and round-nosed. She measures less than two-thirds the length of the nuclear NAUTILUS. This odd creature was designed to do a specific job and to do it well.

Her hull is described as a form of revolution—the cross sections, which are her ribs, being nearly circular. A small outside walkway for personnel and a high fairwater for the 'scopes give the ship a topsail. Just aft of her nose, two gnomelike ears stick up. These are the bow planes. The stern diving planes and rudders are attached to the tail stabilizers that make up the cruciform stern.

A DORSAL rudder, appended to the trailing edge of the topsail, helps to decrease the degree of roll on high-speed turns. Her propeller is driven by a dual-armature electric motor that draws power from a standard GUPPY submarine electric battery.

UNLIKE the popular concept that two are better than one, it is interesting to note that in the case of propulsion systems of ships of equal horsepower, an in-line propeller is more efficient than twin screws because the single propeller has a symmetrical flow about it and operates in the maximum wake.

Internally, ALBACORE is unlike other submarines. Pilot and copilot sit side by side in a small room facing forward. They manipulate airplane control yokes to fly their ship. The control system is unique in that one man is able to control all the planes and rudders—or the task may be subdivided among two or three operators. Amazing fail-safe devices are built into the entire flight-control system.

There are varied and fascinating experimental equipments and systems strung inside the plump shell of the ALBACORE. One of these, the air-conditioning plant, electronically controls the humidity and temperature within the boat to proper values. A pleasant, habitable atmosphere with clean, dry air pervades throughout.

On the surface, at slow speeds, this ship is sometimes awkward, for the single screw and deep draft of the submarine tend to make her sluggish. Normally she is assisted by tugs when operating in confined waters. With a tug bridling her bow, and with judicious use of speed and rudder, ALBACORE responds to commands and can be handled very nicely.

IN the environment for which she is intended—beneath the sea—this incredible little ship has broken through hydrodynamic barriers and established speed sprint records. Her electric propulsion system is only slightly more powerful than that of a conventional submarine.

Summed up, the ALBACORE's speed and maneuverability result from: (1) A symmetrical hull with minimum ship resistance; (2) A single, efficiently designed propeller; (3) Large stern stabilizers and a specially configured tail; (4) A sensitive driving control system for operating the submarine.

Most of the work being done by ALBACORE is highly classified, but little imagination is needed to realize that the problems of friction, boundary layer, acoustics, controllability, and stability are under continuous study. In tests she has figuratively stood on her head, while mechanical recorders inked out each flexure and each bit of useful hydrodynamic data.

RECENTLY, the submerged ALBACORE, minus her propeller, was towed by a surface ship. The test was to establish, among other things, the scaling values between this hull form and its geometrically similar model. Nothing like this submerged test had been recorded before. When the trials were complete, the commanding officer jotted in his report:

"We were notified to come to periscope depth while our towing ship slowed to take in cable. I looked through the periscope and noted that, in spite of my best efforts, ALBACORE was closing up on the mother ship. We had no brakes. As I peered at the formidable shape, we slipped down our tower's side and moved ahead. Each day is a marvel to me, indeed, for here we were without any means of propulsion, under tow, and actually passing our towing ship."

"Final selection and drafting of the proper tear shape for the submarine of the future will be a compromise among ship resistance, desired dimensions, available materials, armament, and operational requirements. . . . Good stability and maneuverability are musts for the future high-speed submarine."

The story of the NAUTILUS has been deliberately kept brief here, for her success and her contribution to submarines of the future have been well written by others and are known to all. The life of the ALBACORE, on the other hand, is told in more detail for the veil has just been lifted on her achievements.

The many particulars that have gone into her design and construction are technical and often difficult to explain. What lies ahead is best summed up by her young and enthusiastic pilots, as they hand-gesture their hydrobatics and speak in new flight terms.

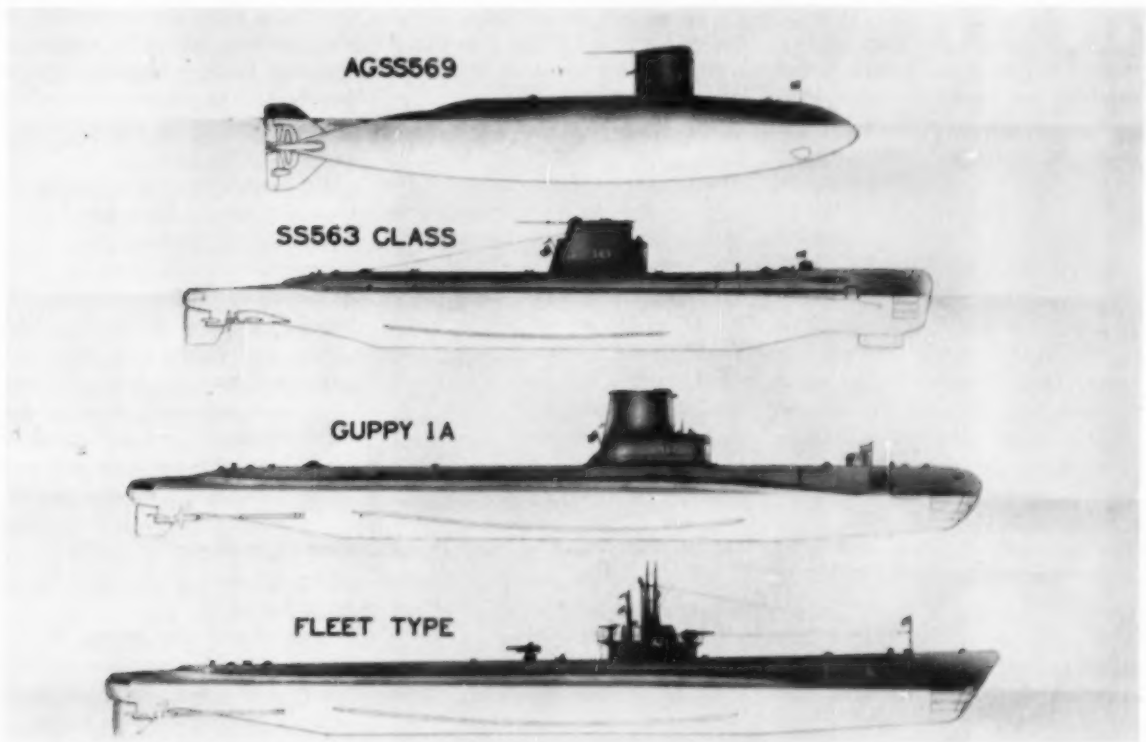
Today we have an underwater hull and an ideal submarine engine. The obvious conclusion is that our Navy will marry the best qualities of each. Admiral Burke pointed the way when he said,

"Nuclear-powered submarines of the near future will be capable not only of making high-speed atomic torpedo attacks on enemy convoys but they will be capable of killing enemy submarines, of providing early warning from enemy threats approaching by air and sea. They will be capable of fueling and supporting seaplanes, of landing marines on hostile shores, of launching guided missiles against targets at sea and on the enemy's homeland. All of them will have two or more capabilities. All will be multipurpose."

WE possess the keystone to a new military weapon. It may have even greater commercial potential in the sea world of tomorrow.

Nuclear power has made the true submersible hull practical and is a forerunner of future undersea developments.

American subs have evolved from fleet type, bottom, to the true underwater hull design, top, since 1945 (Navy photo).



Civil control of the military was con- Even for those few students who early vate true ideas or to advance a healthy

Age of Military Innocence

Despite our recent participation in devastating wars, the huge current budget for national defense, and increasing international tensions, our people take only a casual interest in military affairs

Brig. Gen. Dale O. Smith, USAF

IN spite of the enlightenment of our age, with knowledge sought and disseminated through thousands of educational and research institutions, we live in an era of abysmal military ignorance. There seems to be a conspiracy to keep military understanding from the average American citizen. We even have purged most military knowledge from the study of history, thereby indoctrinating students with a biased and unnatural conception of life on this planet.

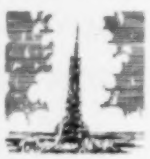
This deëmphasis of things military in the education of our youth is understandable but hardly excusable. It is understandable because school curricula reflect the mores and philosophies of their environment, and the popular belief that militarism is a major cause of war has contributed to disparagement of military learning.

In 1931, Walter Millis published a book, "The Martial Spirit," which suggested that the war with Spain was caused by an irrational public mania for glory and adventure. The reaction to this was to condemn all military thinking as a dangerous pastime.

SCHOLARLY as was "A History of Militarism," written in 1937 by Alfred Vagts, this widely discussed book ridiculed militarism and condemned it as a cause of war. Yet in 1940 the same author, writing for *Military Affairs* said: "For years there has been a curious want of military thinking, planning, teaching, and, above all, of military literature as the expression of such interest." Criticism of the trappings of a profession seldom tends to increase interest in that profession.

General Smith is former director of education at the Air University, Maxwell Air Force Base, Ala., and author of the recent book, "U. S. Military Doctrine." He is currently serving with the Operations Coördinating Board, Washington, D. C.

After World War II, "A Nemesis of Power" was published by John W. Wheeler-Bennett, which supported the view that resurgent German militarism in German politics was responsible for that conflict. These studies and others have been grossly abstracted in glibly recited reasons for the causes of the World Wars. Teachers throughout America can quickly dispose of a most disturbing question of which they have little knowledge by blaming all war on militarism.



Firmly underpinning this recent and overly simplified answer to war is the deep American tenet that a free democracy is threatened by the military. Studies in civil-military relations continue to be premised on this tenet, with seldom an effort to show how the military has preserved and may perpetuate a free society.

The impuissance of military education is certainly understandable, but is it right? Is this contributing to a healthy development of social understanding—to a more secure, adjusted, and free America?

IGNORANCE of any subject does not lead to an understanding and control of it. For this reason the tendency to play down military learning has done us irreparable harm. No one can estimate the price in blood and treasure that already has been paid to this monster of ignorance. Facing a future of the most dreadful kind of military peril, we still trip merrily along the path of military innocence.

A study recently prepared for the Air University, the Air Force school of advanced military learning, revealed the barrenness of military knowledge in our institutions of higher education. Dr. Richard C. Brown of the New York College for Teachers who headed this project sent questionnaires to 815 four-year institutions. Sixty per cent responded, and of that number only thirty-one institutions were found that provided a course in military history or policy. Most such courses were of but one semester and were conducted at the undergraduate level.

It is obvious that outside of subsidized R.O.T.C. programs, military history and policy are given hardly as much attention as basket weaving.

Civil control of the military was conceived as a means of preventing the usurpation of constitutional powers by the military, and it is fundamental to the American system. The Praetorian Guards who selected Roman emperors, the expulsion of Parliament by Cromwell's Roundheads and of the French Assembly by Napoleon, are examples which civil control seeks to avoid.

YET if civil control is to be effective, it must be intelligent. It would seem, then, that civilians who control the military should have a broad understanding of military art and science. Otherwise, in time of crisis, the public is apt to lose faith in inept leadership and cause a change which may not be in keeping with the civil-control principle.

When danger threatens, a frantic search is made for a competent leader. If he can be found only within the ranks of the military, civil control is weakened. A recent example of this was the appointment of Gen. George C. Marshall to the post of Secretary of Defense in 1950. Only three years before, Congress had specified in the law that no one would hold the post of Secretary of Defense "who has within ten years been on active duty as a commissioned officer in the Regular component of the armed services."

Yet a relatively minor political crisis led to President Truman's request that an exception be made, and Congress authorized this one-time-only exception. The fact that no civilian leader could be found with military acumen and in whom the public had confidence is an indictment of the wasted state of our military education. This condition presages a real threat to the concept of civil control of the military.

THE profession of law is the schooling ground for most civil leaders. Of the thirty-three Presidents of the United States, twenty-two have been lawyers by profession, and about the same ratio maintains for other important Government posts. There is precious little in the training for law that prepares for military leadership. Law courses provide not one hour of military study. Even for those few students who early aspire to public service and pursue courses of political science, the problems of war are given but minor consideration within those curricula.

Secretary of State John Foster Dulles wrote in his book, "War or Peace," that "natural science has outstripped moral and political science. This is too bad; but it is a fact and the fact does not disappear because we close our eyes to it."

Since war is such a major factor in our moral and political life, it is inconceivable how we can advance our knowledge unless we study war with all the fervor and intensity we can muster. Could this void in the knowledge of war be responsible for placing us in the deplorable situation we find ourselves today?

When Spenser Wilkinson took the endowed chair of military history at Oxford in 1909 he eloquently expressed the view which today has become a real necessity:

"In our school of *literae humanores* we study the idea of the state; in our schools of history, the life and growth of states. It is to this part of the university's work that the study of war belongs. For war is one of the modes of human intercourse. . . . We are thus bound to study war if we are to cultivate true ideas or to advance a healthy learning."

PERHAPS no other subject is discussed so widely and so heatedly with such ignorance as the subject of war. Avoiding the study of war because of its repugnant consequences is as shortsighted as would be the avoidance of the problem of disease because of its harm to mankind. If war is looked upon as a social disease that needs understanding before it can be controlled, just as human disease is regarded as a physiological phenomenon, then perhaps we could study war without the emotional overtones that tend to mask real learning.

The most repulsive human diseases are dispassionately analyzed by hosts of learned investigators. Yet the rare and courageous individual who attempts to dissect the most injurious ailment of mankind, the social disease of war, is apt to be treated as suspiciously as the eighteenth century medical student who dissected a cadaver.

From the days of the Athenian gymnasia, where the art of war was a primary subject of study, to the scientific academies of Frederick the Great in the eighteenth century, the study of war has had a remarkable correlation with national strength and cultural advance.

Only a militarily well informed public can hope to deal with the problems created by threats of thermonuclear detonations like this (Air Force photo).

sible, from publishing the results of

Perhaps a military author is erron-

ture. The professional military author, in

On the other side of the picture, we find that during the Middle Ages when such education as existed was largely confined to the highly stylized and compended seven liberal arts, chaos and disintegration stalked the Western world. The warnings of Cicero and Quintilian that study should stress usefulness in public life went unheeded.

Today we spend up to seventy per cent of our national budget on things military. This is proof positive that the threat of war is our major national concern. The thirty-five billions of dollars budgeted in the 1956 program is a sum almost too great to comprehend. Knowledge is being created in torrents as the result of this spending. Over $2 billion is directly alloted to upward of 8,000 research and development contracts each year. Weapons and equipment steadily improve, and subsidized research is pouring forth an endless stream of new facts, inferences, hypotheses, and theories.

But is this knowledge assimilated by the minds of the American public? Only superficial use is made of the data after the highly specialized technician looks them over. The average civilian may sometimes get a jazzed-up version through newspapers and magazines, but this adds little to a solid body of knowledge. Almost none of the material is used in schools unless the military knowledge is incidently found to apply to nonmilitary fields.

THE bulk of this new military knowledge is consigned to the shelves of a few service libraries and archives there, except for some minor research by servicemen and civilian employees of the armed services, to gather dust for the ages. Only a handful of engineers or scientists working on particular defense contracts truly profit from what is learned, and no system encourages them to pass it on.

Except in the development of weapons, which are merely the tools of the military art, it is safe to say that more military knowledge is forgotten each year than is taught.

The military services have made gallant efforts to keep this military knowledge alive, to make it more meaningful, and to build upon it. But it is a losing battle. Advanced military schools are provided for a relatively few selected officers. The effort is expensive and, because of closely pared budgets, this kind of in-service education is always subject to close scrutiny and question.

The cultural disparagement of military study, moreover, can be found both without and within the military services. In-service courses are short, seldom extending over a year, and scholarship is often wanting. Many military leaders feel that even this perfunctory and tightly limited educational effort does not warrant the reduction of D-Day forces that it entails, for a man in school is one less man in the combat regiment or the air wing.

Principles of management have taken over in the armed forces, and available firepower has tacitly become a symbol of success comparable to monetary profit in industry. Thus it is far better, goes the reasoning, to have a man in a tactical unit ready to shoot than to have him in a school learning more subtle knowledge about war.

We must have "the most bang for the buck." This makes good newspaper copy on matters of "economy" and looks militarily sound to the uninitiated, but it may not produce the best fighting teams. There is a good deal more to military art and science than the trigger squeeze.

Perhaps it is unfair to the management profession to charge that it is responsible for establishing false criteria of military effectiveness, for most large concerns have extensive in-service educational systems. Industry has found that thorough and up-to-date education contributes to progress and eventual profits.

But this is a management innovation and not universally practiced. Moreover, business is not faced with the ever-present concern of congressional criticism or at least of criticism from leaders who are unskilled in their own profession.

Thus in-service military education is far from adequate for providing broad-gauge military understanding and, of course, with such a paucity of interest in civil institutions the service schools contribute very little to the general body of public knowledge.

How can the wasted state of military knowledge be rectified? Where should we start if we were to decide that it is desirable to incorporate military knowledge into our public educational system?

THE first step would be to encourage the production of military literature. No body of knowledge can long exist without its literature. Through literature the knowledge is abstracted, related, argued, tested, and validated. Literature permits the knowledge to be taught, spread, and integrated with other knowledge. Literature sustains and increases interest and curiosity. Books, ever being revised and written anew, should be the heart and soul of a healthy professional body of knowledge.

Yet everything seems to militate against the publishing of respectable military studies. The problem of security clearances is difficult to solve. Having surmounted that hurdle, who will publish a military book? There is a meager market. With no interest shown by teachers, with a public that has been kept in military ignorance (service in the armed forces with knowledge of certain military techniques and skills does not constitute the kind of advanced military learning considered here), and with armed services that have no great interest in military scholarship, few publishers will take on the risk.

Other professions encourage publication of studies with subsidies of one kind or another. Foundations and professional societies provide immeasurable financial assistance to struggling researchers and authors. Hardly any such assistance is available for a military author. Of all the grants being offered to encourage individual study in every field from anthropology to zoology, only one substantial organization advertises a program for military study. This one exception is the Social Science Research Council which fosters research in civil-military relations.

Nonmilitary professions actively encourage their members to profit, if pos-

sible, from publishing the results of their professional works. A college professor denied the right to publish and sell a textbook in his own field would likely soon seek other employment. The profit motive provides a healthy stimulus to learning and to the dissemination of knowledge.

A peculiar attitude in the military discourages servicemen from publishing for profit. If, goes the argument, a man is being paid by the Government for doing his job, he should devote no duty time to writing for profit, even if the subject matter involves his profession. And if study and writing has been a major part of a uniformed man's official duties, he should not profit commercially as a by-product of this activity.

Is the necessary socialism of military life tending to warp traditional values? Are not free enterprise and the profit system honorable so long as no unfair advantage is taken of any other individual or of the Government?

Business seems to be taking on professional standards, with a growing body of literature, university programs, and confidence and trust in the integrity and judgment of its members.

At the same time the military is adopting older business standards, including all that goes with a 40-hour-week outlook on one's job—acceptance of limited tasks with no thought to ultimate objectives or strategies other than as related to a false monetary criterion and little encouragement for improving professional literature. It must be said that the Air Force is officially encouraging book writing, but this policy is not general throughout the Department of Defense.

PUBLICATION in no way denies the military services the fruits of the serviceman's labors. In fact, publication enhances the results of those labors, because more people become aware of the knowledge thus revealed. One more volume is added to the sparse literature. In-service military distribution of unpublished mimeographed material is a poor substitute for the professional marketing machinery of a publishing house which prints the study attractively and according to the highest standards of workmanship.

Perhaps a military author is erroneously compared to the civil servant who uses his position to profit personally from government contracts. Unfair advantage can truly be charged in such a case.

A military author who surmounts the clearance difficulties and finds a publisher is taking unfair advantage of no one. Actually, by furthering military knowledge he is performing extra Government service. True, those outside the military profession could not

likely write or publish a book on most military matters because they have not been subjected to a military background. Consequently they are not competing, as are businessmen seeking contracts.

The only way that an irregularity could be rightfully charged would be for a military author to "scoop" working journalists with previously uncleared military facts. This administrative problem sometimes works against the military author simply because it is easier to deny clearance than to ascertain that all his military facts have been previously released to the press.

IT can be seen from all this why there is so little reputable military literature. The professional military author, in order to avoid unthinking criticism of his effort, is forced to write at home in his free time. The turmoil of military life is hardly conducive to this effort. Then, if he overcomes clearance requirements ("policy" considerations, incidentally, are far more difficult to deal with than security) he will be lucky to find a publisher who will take the gamble. Some of the best military literature, such as Gen. H. H. Arnold's "Global Mission," just barely made expenses.

There seems to be no rapid way to fill the gap of military literature other than by indirect subsidy. Educational contracts are let for hardware items to sustain technical military knowledge in industry, yet the broader scope of military education itself is woefully backward and finds no comparable Government support. If military books were bought in liberal quantities for service schools and libraries, an adequate initial market would be provided to encourage publishers.

TEXT materials for service schools are generally written by the in-resident faculties who devote a large proportion of their time to preparing these mimeographed or locally printed handouts. This is necessary because reputable published material is just not available. Consequently, we find the ratio of faculty to students much higher in service schools than in civilian schools. It is conceivable that if sophisticated published literature were available, a considerable savings in faculty numbers could eventuate.

A body of respectable military literature would, perhaps, revive the former tradition of scholarship found in the military. With more sober thought and study, it is conceivable that better solutions to the foreboding and fabulously expensive military problems would be found.

Of most vital importance, a body of military literature would make it possible to teach more military subjects in civilian schools and thus lead to the kind of informed public that is far better prepared to control the military and, at the same time, to confront the fundamental dangers of our day.

"Ignorance of any subject does not lead to an understanding and control of it. For this reason the tendency to play down military learning has done us irreparable harm. . . . Since war is such a major factor in our moral and political life, it is inconceivable how we can advance our knowledge unless we study war with all the fervor and intensity we can muster.

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"If war is looked upon as a social disease that needs understanding before it can be controlled then perhaps we could study war without the emotional overtones that tend to mask real learning."

Presidents of Local Posts of the

Thurman F. Naylor
Aberdeen Post

Warren Whitney
Birmingham Post

Edward B. Doherty
Capital Cities Post

Lieut. Col. H. B. Kucheman, Jr.
Florida Post

Stanley C. Hope
Hartford-Springfield Post

Harry Darby
Midwest Post

Leslie R. Groves
New York Post

W. C. MacFarlane, Sr.
Northwest Post

Maurice A. Fraher
Quad Cities-Iowa Post

Brig. Gen. L. I. Davis
Rio Grande Post

James D. Maitland
Rocky Mountain Post

Association

The Local Posts of the American Ordnance Association, located in industrial, scientific, and educational centers throughout the United States, are a vital factor in the Association's task of fostering industrial preparedness.

These Posts by their meetings, seminars, plant visits, and similar activities keep alive an interest in the continuing need for scientific and industrial know-how in the production of the weapons of defense. The presidents of these Posts, most of whom are shown below, are the key men in this nationwide effort for peace.

Thomas Drever
Chicago Post

John D. O'Brien
Cincinnati Post

Albert J. Weatherhead, Jr.
Cleveland Post

Ray C. Malvin
Empire Post

I. Nevin Palley
Lone Star Post

Robert C. Gefls
Los Angeles Post

James A. Ward
Louisiana Post

Herbert R. White
Michigan Post

William H. Worrilow, Sr.
Philadelphia Post

William K. Fitch
Pittsburgh Post

Marmion D. Mills
Puget Sound Post

J. M. Hait
San Francisco Post

W. H. Miner
Texas Post

George M. Riveire
Washington Post

M. Edgar Fain
Yankee Post

square and 22 inches in active length. diameter extension, machined to fit

Packaged Atomic Power

The transportable reactor being built for the Army will be able to supply electrical energy for installations in remote areas at reasonable cost and has interesting possibilities for civilian use

Rear Adm. W. D. Leggett, Jr.

Admiral Leggett is former chief of the Bureau of Ships, Navy Department, Washington, D. C. Now retired, he is serving as vice-president, engineering, Alco Products, Inc., Schenectady, N. Y.

THE term "package power reactor" should perhaps first be defined, since it may be misleading in terms by which we generally think of package power. When one first looks at the size and design details of the Army Package Power Reactor it is difficult to conceive of it as either a packaged unit or as air transportable.

However, it is essentially both. It is a packaged unit in the sense that it is a reactor power unit stripped to the bare essentials required for producing power in isolated areas and has a self-contained fuel supply for about two years of operation. The total weight of the unit is quite comparable to the weight of fuel alone for one year's operation of a conventional plant.

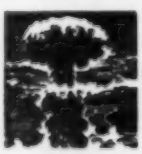
In this concept it is a packaged power unit. It is air transportable in the sense that all components are designed to conform to weight and space limitations of today's transport aircraft.

A full-scale prototype of the Army Package Power Reactor being built at Fort Belvoir, Va. (page 969) contains two exceptions to the above to meet special requirements.

FIRST, the location of the APPR-1 in a populated area, and only eighteen miles from our Nation's Capital, necessitates the use of a vapor container as an absolute safety measure for containment of the worst possible accident. This container is 64 feet high and 36 feet in diameter with walls of ⅞-inch steel plates reënforced with 2 feet of concrete. At a remote location this item, not transportable by air, would be totally unnecessary.

Secondly, the original design for a remote installation has been modified to make APPR-1 more useful as a training facility for military specialists who eventually will be required to operate and service future remote plants. All other original requirements for a simple, reliable, proven power unit whose component parts are transportable by air and easily assembled at any desired location are still valid even though the site of APPR-1 is not remote.

The prime contract for building the prototype APPR reactor at Fort Belvoir was awarded to Alco Products on December 10, 1954, and is the first fixed-price contract for a reactor awarded by the Atomic Energy Commission. Ground was broken on October 5, 1955, and initial operation of the plant is scheduled for early 1957. An extensive testing program is to be completed before the end of that year.



THE APPR is a pressurized-water reactor basically similar to many other power plants contemplated or under construction today. As shown on page 970, the core is housed in a reactor pressure vessel in such a manner as to allow the cooling water (under 1,200 pounds' pressure) to flow upward through the fuel elements at a rate of 4,000 gallons a minute. In passing through the core the temperature of the water is raised from 431 to 450 degrees Fahrenheit.

This primary water then flows to the steam generator where steam is formed at a rate of 34,400 pounds an hour in the secondary circuit under 200 pounds' pressure at 407 degrees Fahrenheit. Since the saturation temperature at this pressure is 382 degrees Fahrenheit, this gives a superheat of 25 degrees.

The steam goes to a conventional turbine generator set to generate 2,100 kilowatts of electricity. We speak of the plant generally as a 2,000-kilowatt plant since there is a station service load of as much as 180 kilowatts.

The reactor core cross section (page 971), is a 20-inch square with the corner elements removed in order to approximate a circle. There are 40 plate-type fuel elements of stainless steel and enriched uranium 2¼ inches

square and 22 inches in active length. Five control rods are employed, four of which are operated in unison as a shimming type of control.

The fifth rod at the center is used for close control in adjusting to the hourly variation of the reactor. All these are operated without servo controls since the reactor has a high negative temperature coefficient and hence is highly stable.

The active portions of the fuel elements are fitted with inlet and outlet end boxes so that the over-all fuel element length is nearly three feet. They are held in position by a top and bottom grid, both of which are supported from a diaphragm within the thermal shield, which is in turn supported by an internal flange in the upper portion of the pressure vessel.

The core is contained within a reactor vessel 4 feet in diameter and 8 feet, 5 inches high. Cooling water is introduced immediately below the flange which supports the reactor and serves to direct the water to the entrance plenum chamber at the bottom of the reactor vessel.

From the bottom, the water flows upward through the fuel elements to the exit plenum chamber, from which the exit nozzle leads the water to the steam generator.

The control-rod drive is indicated on page 970 where it can be seen below the reactor vessel. Two important advantages accrue from this location. First, the rod-actuating mechanism is completely independent of the cover plate, hence no possibility exists for opening of the pressure vessel to precipitate a nuclear incident by withdrawal of control rods. Secondly, the major part of the drive system is made more readily accessible for maintenance and adjustment.

THE control rod consists of a hollow structure into which removable fuel and absorber portions are inserted, each equal to the active length of the core. The consumable portions can be removed and replaced without disturbing the mechanical adjustments of the control rod drive system.

Integral with the hollow rod structure at its bottom end is a one-inch-diameter extension, machined to provide a rack. A pinion engages this rack and is driven by means of a shaft which brings the shaft seal well out to the side and into an area where the radiation intensity is low enough that induced activity is of no consequence.

The seal itself is a labyrinth-type disk seal with clean water introduced near the inner end. A slow inward leakage of pure water occurs under a slight pressure differential, but the major flow is outward under the nominal 1,200-pound pressure differential between the pure water and the outside atmosphere. The existence of the buffer zone of pure water assures that no radioactivity leaks through the shaft seal.

A clutch is used for quick disengagement of the rod and drive motor so that the rod may be released to fall under the action of gravity with an acceleration of ¾ G. The clutch is driven by a gear motor whose signal is received from the electronic instrumentation conventionally associated with reactors.

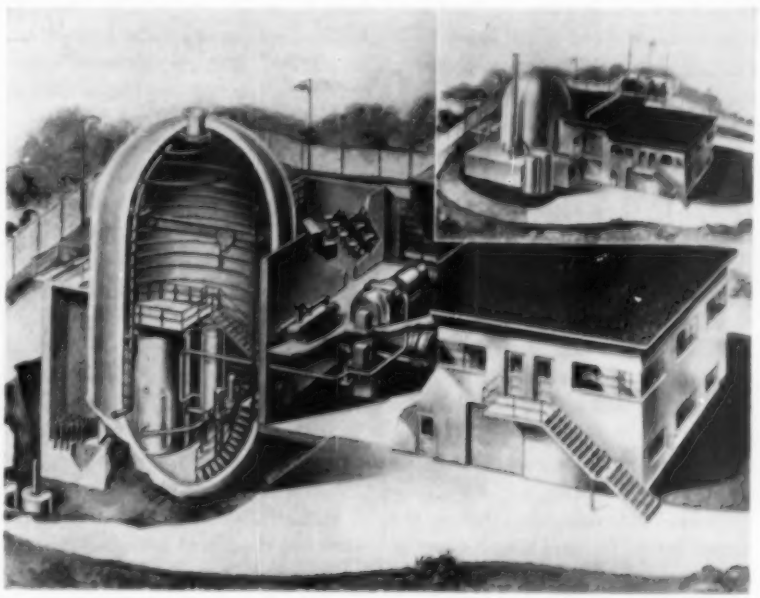
A UNIVERSAL joint and jackshaft arrangement permits mounting the motor on the foundation structure independent of the reactor vessel. In addition to eliminating stresses due to uneven thermal expansion, this arrangement permits ready replacement of either a gear motor or its shaft seal without disturbing adjacent units.

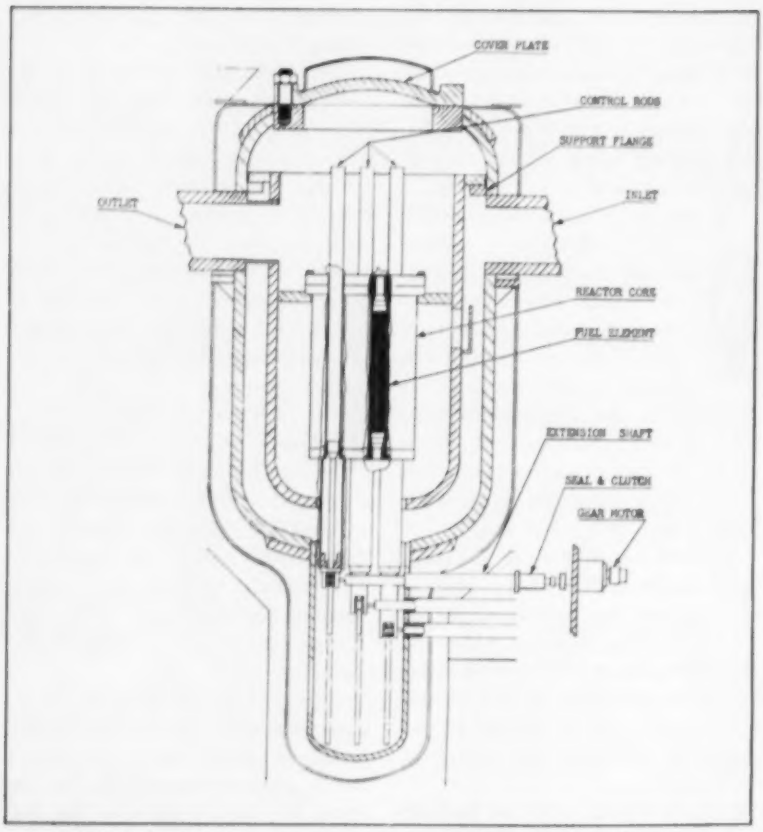
A primary shield surrounds the reactor pressure vessel and consists of 8 layers of iron two inches thick in a water tank forty-seven inches thick radially. The neutron attenuation is more than adequate for radiological safety purposes. The gamma attenuation of this shield is sufficient to reduce the radiation leaking from the core to a level equal to that due to the primary coolant water in the pipes, pumps, and steam generator.

THE final shielding is accomplished by the 2-foot-thick concrete lining of the vapor container supplemented by an additional three feet outside of the vapor container in the operating levels. The resulting radiation level in continuously occupied areas is of the order of twenty per cent of the accepted maximum safe values.

When fuel is to be changed, the reactor vessel cover plate is removed, following which the upper retaining grid can be removed exposing the fuel elements and the control rods. The well above the reactor is filled with water at all times so that the fuel elements are always submerged at least twelve feet. This depth of water provides enough shielding to prevent overexposure of personnel working on the

Cutaway drawing of APPR, first atom-powered, air-transportable generating plant.





Detailed drawing of reactor pressure vessel built to house APPR core.

platform at the top of the tank during the short period that fuel elements are actually being transferred to a spent-fuel storage pit.

The military forces have many demands for power not apparent to their civilian friends. A chain of bases has been established and is still being built throughout the world, and the power requirements of these bases cannot normally be supplied from local utilities —if there should happen to be any.

EVERY item of logistics support that can be eliminated means fewer convoys or supply trains that might have to get to these bases under war conditions. Long exposed supply lines are areas of military vulnerability. It is the job of the armed forces to foresee and eliminate or reduce such weaknesses. Nuclear power plants making our outlying bases more independent would be a step along this path.

Another little-recognized chore of the armed forces is furnishing power in devastated areas. We had two destroyer escorts and hundreds of small Diesel engines pumping power into the city of Manila for months after we recaptured it. A thoroughly transportable power plant utilizing nuclear fuel could greatly reduce the effort that would have to be devoted to such work as this in a future war, and the men, ships, and transport which would thereby be released could be devoted to the offensive effort.

Nuclear package power plants can provide many other functions in isolated locations which will merely be enumerated and not elaborated upon. They are really quite obvious in themselves. First, history indicates development in any new field is often fraught with many "cut and try" methods to develop the necessary technical knowledge. The more power plants we have in isolated regions the faster we shall develop information to close these gaps in our knowledge.

Secondly, we also know from experience that the cost of any novel development comes down as we build more units and development costs are absorbed. Why not put this novel power plant where we can clearly justify the cost today and use this experience in getting the cost down to the point where such plants will find their way into new markets closer to home.

Thirdly, these plants will reduce the number of people who have to live in these desolate spots or face the hazards of going to and from them in time of war. We are currently asking the coming military generation to adjust to some living conditions to which only the lighthouse keepers of our generation have had to adapt themselves.

There are many other military applications which would fall within the responsibilities of the Army Engineers. The Navy, of course, has similar responsibilities for its bases ashore and its vessels at sea.

ON the civilian side in today's economy in these United States are several applications of interest. These nuclear package power plants are rapidly becoming competitive with conventional plants in many high-fuel-cost areas, even in this relatively early stage of their development. Direct utilization of a 10,000-kilowatt power package is possible and economically justifiable in some areas today, as will be indicated later under cost evaluation.

A second potential civilian utilization can be realized by adapting a package power reactor also to provide research facilities for our educational and medical institutions. Utilization of some or all the power produced would obviously reduce the over-all costs of nuclear research, thereby facilitating the technology and development of this field for the benefit of mankind.

A great many civilian power plants are operating in what could be called the package-power range, such as industrial establishments where most requirements would be met by a reactor capable of forming steam for 10,000 kilowatts. Such a unit could carry the heating load as well as furnish all or part of the electricity required.

It seems appropriate to close this article with a consideration of the economics involved for civilian and military utilization of package power re-

actors. This is done with great trepidation for many reasons.

First and most important, our company is currently building its first package reactor. While it is far enough along to provide technical data on what were considered as doubtful points initially, we are keenly conscious that until such time as we have completed our guarantees under the contract we do not really know the total cost.

SECONDLY, it is felt our present cost estimate may be overly optimistic, even though it is apparently well founded. Optimism at this point in the development of our first package reactor should be tempered with a certain degree of wariness. Although the technology has previously been developed and the system is relatively inexpensive, with present estimates based on firm price quotations from all outside suppliers, many other factors can upset any estimate given.

In view of all this uncertainty, our company is presently striving toward a figure of 18 mils/kwh for a 10,000-kilowatt enriched-uranium, pressurized-water plant similar to the APPR. It is interesting to note that the cost of such a unit agrees very well with that predicted by Rear Adm. H. G. Rickover at the Pressurized Water Reactor Forum held on December 2, 1955, for a future improved nuclear plant similar to the one being constructed for Duquesne Light Company at Shippingport, Pa.

Admiral Rickover predicted a future total cost of 14 mils/kwh for a standardized 90,000-kw plant after two stages of development. He pointed out that "the Shippingport plant is being built primarily to advance nuclear power technology rather than for the purpose of immediate economic power generation."

COSTS ranging from 52 to 39 mils/kwh for the first developmental stages of this larger plant, with its special development and engineering problems, are therefore understandably high at this time.

Alco Products is well aware that all these costs are higher than most central-station generating plants in the United States today would consider. There are, however, many other factors. There are parts of the world which do not have chemical fuels and have never had them.

There are other parts of the world which have had an abundance of these fuels and which can now see the end of their supplies and are looking anxiously toward something which will ensure their continued supply of electric power.

There are even some areas in the United States where power generation costs actually are running as high or higher than indicated, particularly in the smaller power plants.

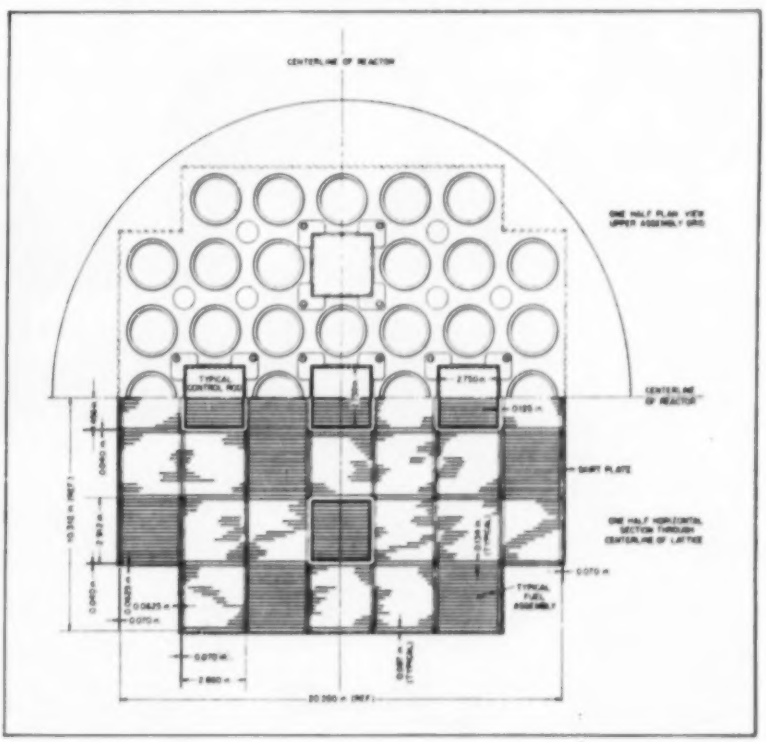
Consider finally, the economical advantage of a nuclear 10,000-kilowatt remote military power plant when the cost of transporting chemical fuel outside the United States is included. In locations where port facilities are unavailable or icebound most of the year, it must be assumed the fuel would be transported by air.

It has been calculated that fuel-transportation costs alone would amount to approximately 23 mils/kwh for a conventional power station only 1,500 miles from its continental U. S. supply base and would require 500 fueling flights a year. Comparing this with the negligible cost for transporting nuclear fuel to the same remote station once every two years, one can easily visualize the tremendous economic and strategic potential the nuclear plant offers our military forces.

Fuel transportation costs would be virtually eliminated along with releasing many aircraft and their crews for more effective military operations. The resultant total costs of a 10,000-kilowatt nuclear plant to our Government is about half the cost of a conventional chemical plant of the same capacity in remote regions.

WITH the above facts in mind, we foresee a particularly bright future for the small nuclear power plant—first to meet the present-day military requirements of our Government in remote areas where the need justifies the cost and later to meet the increasing civilian demand throughout the world as developments made in the first stage make the plant competitive with conventional-type plants.

Cross section of reactor core showing fuel elements and control rods.


CENTERLINE OF REACTOR
ONE HALF PLAN VIEW UPPER ASSEMBLY GRID
TYPICAL CONTROL ROD
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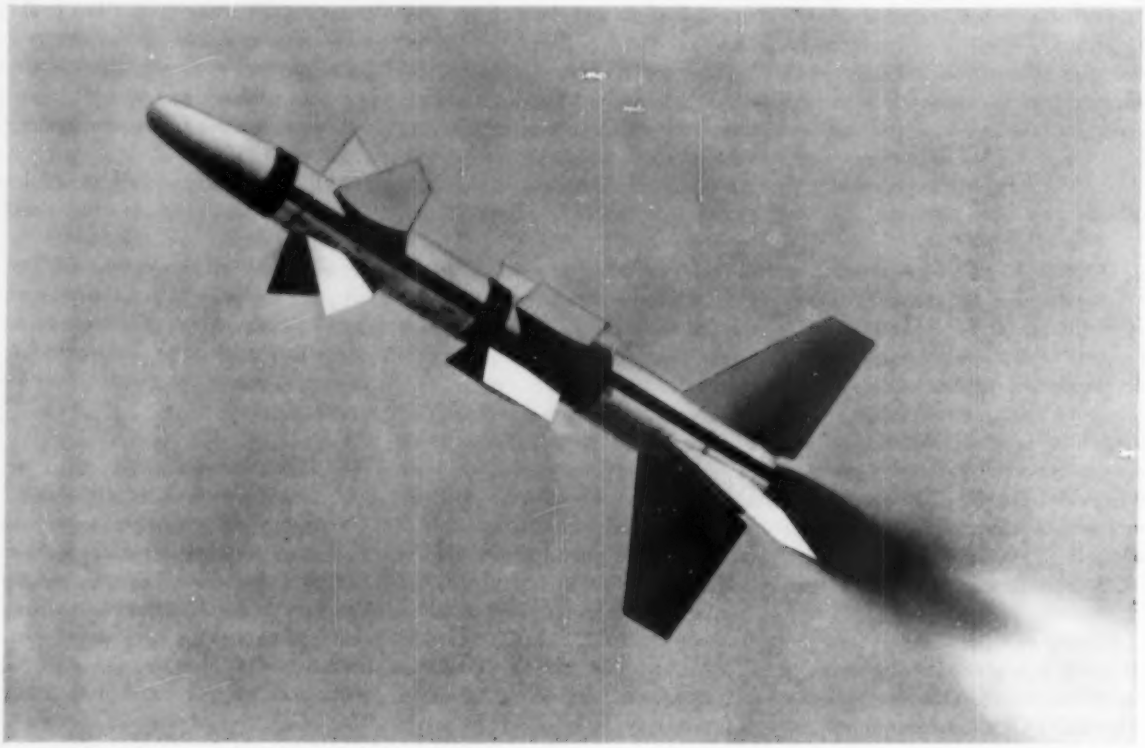
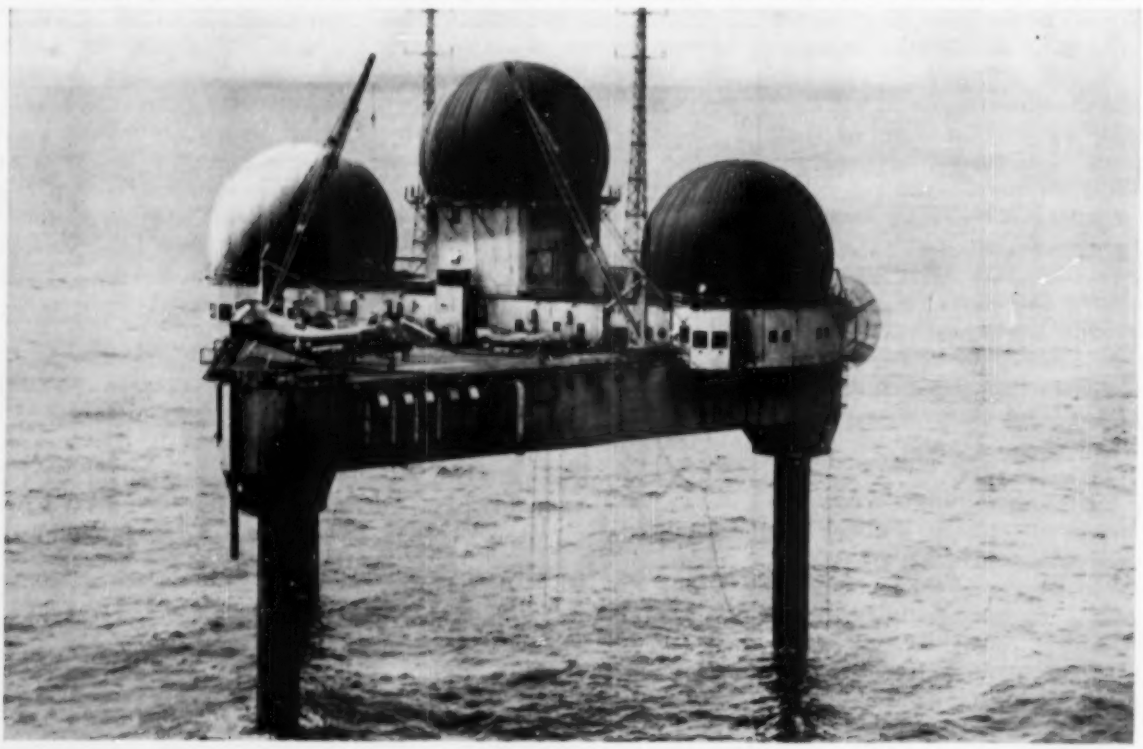
ONE HALF HORIZONTAL SECTION THROUGH CENTERLINE OF LATTICE
TYPICAL FUEL ASSEMBLY

For Continental Air Defense



The Talos, above, the Navy's new supersonic surface-to-air guided missile, will be used on shipboard to supplement the Terrier and by the Continental Air Defense Command to supplement the Nike (Navy photo). The 6,000-ton Texas Tower, below, is one of a chain of man-made offshore "islands" forming an early-warning radar network from Newfoundland to Virginia.



Metrology and Production

The new Eli Whitney Metrology Laboratory is supplementing the work of the National Bureau of Standards in supplying industrial needs for certified precision standards vital to dimensional control

Dr. Allen V. Astin

THE business of the Eli Whitney Metrology Laboratory and of the National Bureau of Standards is the advancement and utilization of physical measurement techniques.

Measurement, we should all know, is the scientific key to our modern economy. It is the essential basis for mass production, the essence of which is the fabrication of interchangeable parts—parts which can be produced under measured and controlled conditions so that they remain within allowable limits of dimension and uniformity. Dimension can be man's servant when properly managed.

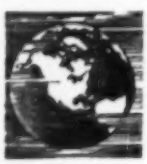
It is sometimes not appreciated that each advance in the field of measurement and each refinement in the methods of making measurement bring with them important benefits to industry and thereby to our society. Throughout history, each major advance in industrial efficiency and productivity may be related to some advance or refinement in the measurement process.

DURING Eli Whitney's time, measurement accuracy to a thousandth of an inch represented an extremely high degree of precision. Today, this laboratory can certify measurements to a precision of one-millionth of an inch. Such advances and refinements lead to new precision which ultimately can be physically translated into better, more reliable, and longer-lasting products.

Dr. Astin is Director of the National Bureau of Standards, Washington, D. C. This address was presented at the opening of the Sheffield Corporation's Eli Whitney Metrology Laboratory, Dayton, Ohio, February 17, 1956.

It is somewhat difficult for the average consumer to appreciate that when he uses such a familiar thing as an automobile, a television set, a refrigerator, or a telephone that he is operating a complex technical device which could not have been made at a price which he could afford without extremely advanced measuring techniques.

Yet each of these devices consists of a wide variety of precision components which must meet exacting requirements of dimensional control. They must be made to conform, within certain tolerances, to rather rigid specifications, in order that they may be integrated into an operable assembly.



Furthermore, there must be precision gages and other accurate measuring instruments available to the production staff in order that many workers with limited skills can assure accurate conformance of each component to its specified physical characteristics.

But another element is necessary for really effective interchangeability. When a device consists of two or more components made in separate machines, the measuring equipment used to control or define the character of each component must be referred to a common measurement standard. Otherwise there is no guarantee that the parts will fit or operate together properly.

IF a manufacturer fabricates all his own parts and processes all the raw materials he needs, he might achieve limited success with his own measurement standards. But if he buys components or materials from others or if he sells his product to be used in conjunction with other products or if he guarantees his product to have certain physical characteristics, there must be available widely accepted measurement standards.

The basic and primary standards are the principal responsibility of the National Bureau of Standards. It is a unique function of the Bureau to develop and maintain standards for physical measurement. Associated with this function is the responsibility to develop methods of measurement and to provide science, Government, and industry with information and methods for applying these standards to their needs.

When the National Bureau of Standards was established in 1901 it had custody of two primary standards of physical measurement—the meter and the kilogram. The length standard is a

bar of platinum-iridium, and it defines the meter. From it we derive, by precise numerical ratios, the more familiar units of inches, fraction of inches, feet, and so on. The development of such a standard, which is a prototype of a widely accepted international standard, represents an appreciable advance over the varied and nonuniform standards of earlier times. It has allowed for considerable advances over earlier measurement techniques.

Since the acquisition of these two standards, phenomenal advances in science and technology have made it necessary to provide hundreds of other standards in newly opened areas. The development and effective utilization of these many new standards have required major expansion in our work on measurement techniques. We now have devices and methods for measuring not only length and mass but also electric power and voltage, temperature, color, light intensity, heat energy, and X-ray and radioactive intensities.

Yet in all this new measurement work the meter and the kilogram are still of fundamental importance because, together with the rotating earth as a time standard, they constitute the three primary standards upon which all scientific measurements are based. Thus, because of the wide application of these primary standards to the hundreds of other standards, they take on added significance.

IT is in the advancement of dimensional measurement that the National Bureau of Standards shares a common interest with this new laboratory. Both our organizations seek to find better ways to further dimensional control and to apply this to industrial development. The job is a big and important one. It grows bigger every day.

We know this from the very growth of American industry. We know it from the increasing demand for measurement and testing services. We know it from the urgent requirement for new standards and from the need to improve and refine existing standards. And we know it from the demand for new and better measurement methods and instrumentation.

The demand is so great, in fact, that no one organization can adequately service the need. In the case of the National Bureau of Standards, our responsibilities associated with providing and extending the fundamental standards require that we limit our services to industry by undertaking activities which can best be performed by or are unique to the Bureau. Thus, we look to highly competent laboratories, such as the Eli Whitney Metrology Laboratory, to give to industry many services that it needs.

Although several private laboratories have made available services in other fields of technology, there has been a lack of commercial facilities which could undertake adequately the services needed in dimensional measurement and in extending the availability of the reliable reference and working standards which assure dimensional interchangeability.

This laboratory will go a long way toward meeting this need. We welcome it into the community of precise measurement. We know that under the aegis of the Sheffield Corporation it will flourish by providing outstanding measurement services.

The name, "Eli Whitney Metrology Laboratory," is very apt for this laboratory. It honors Eli Whitney who was among the first to recognize the importance of the measurement sciences and who understood the critical relationship of measurement to industrial production.

He is the father of mass production, for he was the first to demonstrate the principle of interchangeability of parts. It was his vision, I think, which led to such organizations as the National Bureau of Standards and this laboratory named for him.

I should like to mention the excellent and up-to-date equipment which has been gathered in this laboratory.

The instruments collected here, I am sure, will provide industry with the latest technical assistance available to the field of dimensional measurement. The currency of this equipment makes me feel certain that the staff of this laboratory will keep up with all advances in measurement and so keep this laboratory as modern as it is now.

I notice that one of the published purposes of the Eli Whitney Metrology Laboratory is to "supplement on an industrial basis the work of the Metrology Division of our National Bureau of Standards in supplying industry with certified precision standards for dimensional control in the production shop, tool shop, and in the gage laboratory."

THIS is indeed modest. I look for more than that from this laboratory, and I think that Dr. Irvine Gardner, who is chief of our Metrology Division, expects more. We believe that this laboratory will join with us in our continuous effort to improve the measurement process and all that is associated with it. We think that an interest in measurement service carries with it an interest in measurement research. Therefore, we are looking foreward to new developments, new techniques, and new and better instruments from this laboratory.

The dependence of advances in our technological economy on new and more precise measurement techniques is such that precision can be called a measure of progress. Furthermore, the extensive dependence of technology on basic science again involves the measuring process since science itself is intimately dependent on the tools and techniques of measurement.

These relationships apply to this laboratory. Not only can it give major assistance in meeting the large demand for measurement services using today's best techniques but it can aid in research on better techniques to meet the more rigorous demands of the future. I am confident that the staff of this laboratory will measure up to such a challenging opportunity.

THE National Bureau of Standards is most happy to see this laboratory come into existence. It will help greatly to relieve the tremendous burden of dimensional testing service which is now needed by industry. It provides a competent commercial facility to assist in America's industrial growth. And we at the National Bureau of Standards hope and expect that it will join us in the never-ending quest for greater and greater precision.

Measurement for Survival

Research to lessen chance of bodily injury from aircraft crashes and high-speed bailouts is being furthered by volunteers riding rocket sleds to test the effects of very rapid starts and stops

Lieut. Col. John P. Stapp, U.S.A.F.

HIGH-SPEED transportation is possible at the risk of abrupt decelerations involving forces of rapid onset, great magnitude, and comparatively brief duration capable of injurious or lethal effects to living organisms.

In military aviation, the loss of life and the incidence of total disability from accidents were sufficient to justify investigation of the relationship between force characteristics and their biological effects, a field of research designated as "biodynamics."

Two main lines of application for this research have existed to date—protection from forces incurred in aircraft crashes and tolerance to conditions of escape from high-speed aircraft by seat or capsule ejection.

The growing feasibility of rocket-powered human flight as a mode of transportation introduces a third area of practical application in which problems of tolerance to high-speed acceleration as well as to prolonged high deceleration demand solution.

IN order to accomplish precisely controlled exposures of living organisms to predetermined configurations of mechanical force with reasonable safety, the chosen instrument has evolved as a rocket-powered sled, slipper-mounted on rails, carrying the subject, recording and transmitting instrumentation, and braking devices, which can be accelerated to the required velocity and then decelerated in measurable and reproducible configurations by prearranged braking systems.

Colonel Stapp is chief of the Aëro Medical Field Laboratory at Holloman Air Development Center, N. Mex. This article is based on an address given by Colonel Stapp before the Eleventh Annual Meeting of the A.O.A. Dimensional Standards and Metrology Division at Watervliet Arsenal, Watervliet, N. Y.

By this means, anthropometric dummies, anesthetized animal subjects, and human volunteers have been exposed to mechanical forces reproducing those encountered in aircraft and automotive-vehicle crashes and to wind drag deceleration incident to escape from high-performance aircraft.

This investigation was begun in 1946 by the Aëro Medical Laboratory of Wright Air Development Center in order to obtain urgently needed, accurate information concerning the tolerable and survivable limits for man exposed to dynamic forces of short duration encountered in crash-type decelerations.

A competitive design study resulted in the development of a linear decelerator, consisting essentially of a rocket-propelled sled which could be decelerated or stopped by mechanical friction brakes in a predetermined manner.

Northrop Aircraft, Inc., of Hawthorne, Calif., designed, fabricated, maintained, and operated the equipment under the direction of the Aëro Medical Laboratory during the three completed phases of the experimental program, between April 1946 and June 1951. Edwards Flight Test Center, at Edwards Air Force Base, Calif., was chosen as the first base of operations because of the availability of a precision-built, 2,000-foot-long, standard-gauge railroad track. In general, the Edwards equipment and its operation may be described as follows:

1. *Linear decelerator*—A 1,500-pound sled of chromium-molybdenum steel tubing, approximately fifteen feet in length, stressed to more than 100G with a safety factor of 1.5 and designed to carry a seat or litter and instrumentation. Propulsion of the slipper-mounted sled along the rails is obtained by one to four solid-fuel jato-type rocket motors providing a thrust of 1,000 pounds each for 5 seconds. Two braking keels are mounted parallel lengthwise beneath the sled.

2. *Braking system*—There are 45 independently pressurized and actuated units in a 50-foot area between the rails beginning 1,250 feet from the west, or starting end of the track. Each unit consists of 2 parallel pairs of brake shoes, 5 by 11 inches in area, closed by pneumatic-hydraulic-actuated levers which compress the shoes together at pressures up to 600 pounds per square inch and

clasp the moving keels attached to the sled with an action resembling that of a knife blade being pulled through a vise.

THE sliding friction forces at 600 pounds per square inch are based on a coefficient of friction of 0.06, and a maximum coefficient of 0.20 approaching static conditions. At this pressure, the threefold rise in coefficient of friction began at speeds below 35 miles an hour. A fairly constant coefficient of 0.06 prevailed in the range from 40 up to 200 miles an hour.

3. *Emergency braking system*—Five hundred feet beyond the main braking system a cable is wound on hydraulic brake drums on either side of the track and arranged to catch on an arresting fork on the front of the sled and pull it to a halt with a drag not exceeding 10G.

4. *Instrumentation*—Recording devices include a 4-channel FM-AM telemetering system, a space-time recording system, a 16-mm. camera mounted either on the front or the rear of the sled, and a battery of six Eastman high-speed movie cameras spaced to give overlapping coverage of 10- to 12-foot sectors of the braking area. There is also a ribbon-frame camera covering the entire braking area and a Micronex high-speed X-ray which can be positioned astride the track over any part of the same area. A 6-channel, self-contained magnetic tape recorder is also used to corroborate the more accurate data obtained by telemetering in a series of runs.

5. *Operation of the decelerator*—Supervision and remote control of all firing operations originate in a control room or, in later experiments, in a tower 30 feet high located 250 feet south of the brake area. Communication is conducted by means of a field telephone system and by an intercommunicating public address system which has loudspeakers at the brakes, at the selected starting point for a run, and in the laboratory area.

BOTH systems are operated from switch panels in the tower. Control panels with time relays for activating instrumentation in proper sequence, rocket-firing controls, and meteorological instruments are also located in the tower. Preparatory to a run, the subject is strapped in place, all instrumentation is connected and calibrated, and all firing circuits are connected with safety plugs in place.

The engineer in charge of operations then goes through a comprehensive check list by intercom and keeps all operations under visual observation with binoculars from the control bridge in the tower. On completion of the check list, the firing sequence is started.

The engineer closes a 10-second-delay time relay switch activating the 230-volt, 10-ampere circuit to the rocket igniters, meanwhile counting down over the speaker system from 10 to 1.

AMPLE time for setting off the rockets is assured by fifteen feet of slack in the cables to the igniter quick-disconnect plugs which separate when the motion of the sled takes up the slack. The rocket thrust accelerates the sled to the burnout point in five seconds, allowing it a brief coasting period before entering the prearranged configuration of brakes.

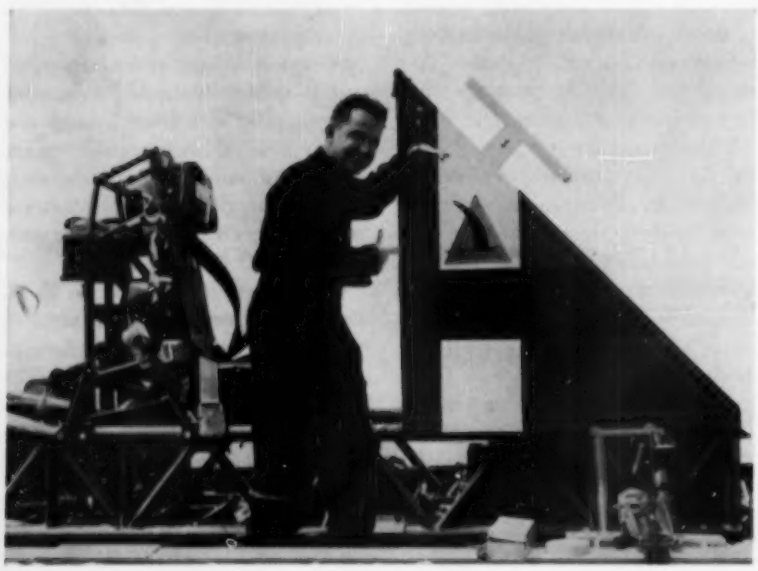
Cams on the frame of the sled strike levers on the preset brakes, triggering them off in the desired prearranged sequence. The rate of onset of deceleration is controlled by the tripping sequence. Using alternate brakes gives slopes of about 500G per second. When cams are arranged to trip two brakes at a time a rate of onset from about 1,450 to 2,200G per second is produced. When three brakes are tripped simultaneously, the rate of onset is 2,900 to 3,400G per second.

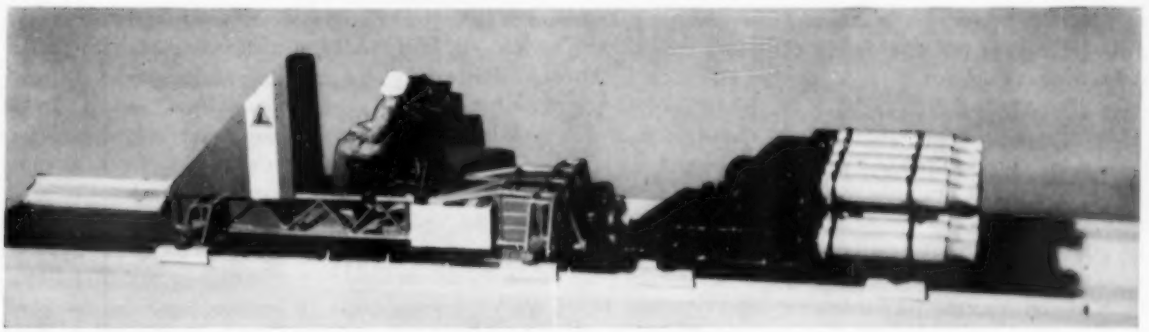
The magnitude of deceleration is controlled by the number of brakes engaged at one time on the braking keels attached to the undercarriage of the sled. With twenty consecutive brakes at 600 pounds per square inch closing pressure, the sled can be stopped in the brakes from any velocity achieved by 3-rocket propulsion, and twenty-four brakes will halt the decelerator in any 4-rocket run.

EIGHTY-EIGHT experiments were accomplished with chimpanzee subjects to explore the performance range of the decelerator and to establish safe parameters for human experimentation with the same equipment. The use of animals of the size and ferocity of chimpanzees was justified by the close approximation to human masses, dimensions, and reactions.

Subjects were presented to linear decelerations while seated facing forward, seated facing backward, seated facing sidewise, lying supine feet first, lying supine head first, and lying transversely

Lieut. Col. John P. Stapp shows the forward half of the rocket sled in which he rode at a speed of 632 miles an hour. Test seat is at left (Air Force photo).





Scale model of rocket sled showing test vehicle, propulsion unit, and concrete-embedded steel rails (Air Force photo).

across the sled while facing to the rear with the back against the bulkhead.

By this means it was determined that four of the positions were potentially dangerous for human subjects in case of loss of control or malfunction of equipment. Therefore, human experiments were confined to the forward-facing and backward-facing positions.

Seventy-three of the experiments were performed with human volunteers. They included three flight surgeons, one pilot, two parachutists, two harness makers, a medical technician, an aërial photographer, an aërial gunner, and an ordnance specialist. One of the flight surgeons was also a pilot. Ages ranged from 25 to 41 years, weights from 142 to 206 pounds, heights from 66.5 to 72 inches.

The range of body sizes and somatotypes usually encountered in the Air Force was well represented, considering that only twelve subjects were used in the experiments. The maximum number of exposures to decelerative forces sustained by any one subject was twenty-six, including the most severe tests of the series. No sedation or medication of any sort was used with human subjects either before or after tests.

BOTH chimpanzee and human experiments were characterized by a close correlation between predicted and measured results, as well as reproducibility of experimental configurations that indicated a high degree of precision and control in the operation of sled and brakes.

Concurrently with the evaluation of tolerance limits, development of harness configurations was accomplished. Optimum restraint configuration for the forward-facing seated position was proved to be the shoulder straps, lap belt in 3-inch-width nylon webbing, with a pair of tie-down straps known as the "inverted-V" to hold belt and shoulder straps down against the bottom of the seat.

It was established conclusively that very high decelerative force can be sustained by primates, provided there is adequate protection from collision with solid objects. The maximum deceleration sustained by a chimpanzee in this series was from 174 miles an hour to a stop in 27.5 feet in the supine head-first position.

This could have been survived with some temporary disability by a human.

It is many times what would be encountered in any automobile collision or airplane crash short of complete demolition.

IN order to evaluate the effects of impacts of high rate of onset and short duration, capable of lethal effects, a device known as a monorail decelerator was developed. The monorail decelerator consists of a welded steel carriage sliding on and suspended from a lubricated horizontal rail. Propulsion is derived from an aircraft seat-ejection catapult.

The carriage was decelerated by striking a lead cone attached to a frame welded to the rail. The coefficient of restitution of lead is sufficiently low to result in almost complete absorption of the energy of the carriage, thus minimizing rebound. Variations in the deceleration pattern were obtained by using different sizes of cones.

The tubular steel carriage was modified for experiments one through thirteen by the addition of a duraluminum subject holder which was bolted to the front of the carriage in such a manner that it might be raised or lowered with respect to the carriage.

A RAMLIKE structure supported the wooden impingement block and also provided a means for measuring the force expended upon it by the decelerating subject. The vertical position of the impingement block support could be grossly adjusted.

The force exerted upon the impingement block by the decelerating mass was sensed by means of a strain gauge mounted upon an accurately calibrated load block. The force was transmitted to the load block via the ramlike structure which supported the impingement block. The inertia and the mechanical advantage of this system were taken into account. All working parts of the impingement-block support were precision-machined.

Uninjured survival of anesthetized hogs occurred in all experiments up to 80G in the backward-facing seated position and to 125G in the forward facing seated position.

The comparative vulnerability of chest, midriff, and abdomen for impingement by the simulated instrument-panel section, control wheel, and stick were determined in lethal experiments. Forces that could easily be sustained without injury while the subject was restrained with webbing produced fatality when the subject was impinged against the solid test objects.

A total of fifty-two experiments have been accomplished with this device to

date and are as yet of a preliminary nature because of the large variety of configurations employed.

IN order to reproduce the factors of escape from high-performance aircraft for the purpose of determining tolerance limits and modifications required to extend them, a high-performance decelerator was designed and built by Northrop Aircraft, Inc., contractor for the project, for use at Holloman Air Development Center where a 3,500-foot rocket-sled track was available. This was an 84-inch gauge track with a 60-inch-wide, 18-inch-deep concrete ditch for water brakes running the full length between the rails.

The high-performance decelerator consists of a test sled weighing 2,000 pounds carrying the subject and instrumentation, pushed by a propulsion sled on which solid-fuel rockets are mounted.

The test unit is separate from the propulsion vehicle to reduce the weight and consequently the drag required of its water brake in attaining desired high-inertia-force levels. Both vehicles are mounted on dural slippers with stellite bearings surrounding the rail head.

The two units are propelled along the track by solid-fuel rockets and subsequent to rocket burnout are retarded by water brakes.

The chrome-molybdenum steel tubing test sled is of sufficient size to accommodate a single test subject in one of several configurations, an onboard telemetry system, high-speed cameras, and the water brake. Its construction embodies structural elements necessary to withstand safely the repeated application of decelerative force patterns of large magnitude with high initial rate of build-up.

IT is equipped with one solid windshield for deceleration tests, and a frame holding two full-length doors for windblast tests. Abrupt onset of windblast is achieved by triggering open the doors with a cam placed between the rails at a predetermined point.

For evaluating tumbling in combination with deceleration, or the combined effects of tumbling, deceleration, and windblast, a seat mounted on gimbals replaces the fixed seat on the sled. In it a subject can be rotated head over heels by a bungee shock cord mechanism and stopped within two seconds by disk brakes. All components are designed to 100G, with a 1.5 safety factor.

Both sleds have fixed-scoop water brakes mounted under the chassis. Water entering the scoops on the test sled is turned ninety degrees through conduits and ejected to the sides. A retarding force of approximately one pound for each pound of water passing through the conduit is applied to the sled. The propulsion sled also has fixed scoops but of lower clearance, so that braking begins at a shallower depth of water. The U-shaped conduits on this sled turn 180 degrees, throwing water forward during deceleration. About two pounds of retarding force results from each pound of water passing through them.

The lower-clearance scoops and higher retarding forces provided by the 180-degree turn in the ducts on the propulsion sled ensure its immediate separation and retardation apart from

the test sled, which enters the water brakes at a safe interval beyond the propulsion sled and is decelerated in the predetermined inertia force pattern required for the subject or article being tested.

Construction of the Holloman track permits the programming of water-brake sections at any desired location along the entire 3,500-foot length by installing frangible masonite dams to establish the required water height in a trough running the full length of the track between the rails.

At 10-foot intervals are slots in the concrete walls of the trough which permit insertion of masonite partitions of the height required to hold the predetermined depth of water to be used in braking. The volume of water picked up is determined by the depth of the fixed sled scoops as they knock out the partitions and take in water impounded between them.

Test-sled instrumentation consists of inboard high-speed motion-picture cameras aimed at the subject and a maximum of 12 channels of Bendix AM-FM telemetering adaptable to appropriate sensing devices such as strain-gauge accelerometers, bonded strain-gauge tensiometers, wind-pressure pickups, electrocardiograph pickups, and electroencephalograph leads.

MAX ROTHMAN, of the electronic instrumentation section of Holloman Air Development Center, developed the Sleran system, an electronic track instrumentation equipment for the collection of space-time data on sled runs. The method consists of the sequential discharging of capacitors along the track through gaseous diodes which are triggered by a confined radio-frequency field carried by the sled.

The resultant signal pulses are propagated on a coaxial cable to the track blockhouse where their position and time quantities are digitalized and recorded on a multichannel magnetic tape recorder in binary-coded decimal form. Both analog and digital methods of data handling and playback are featured. Over-all accuracy of velocity measurements is plus or minus one foot per second at 1,000 feet per second.

An optical method of slightly lower accuracy is used as a secondary check on velocity. This consists of a sequence of ribbon-frame cameras at fixed stations with overlapping coverage parallel to the track.

Photographic recording of displacement in relation to a time signal flashed on the film permits velocity to be determined, with all necessary corrections for angular displacement and other factors inherent in an optical system of this sort.

HIGH-SPEED motion-picture cameras at 750 frames a second are available to record events in particular positions along the track, such as at the water brakes. Other instrumentation of a classified nature is used as the occasion arises.

Propulsion power is obtained by use of from one to twelve solid-fuel rockets of 4,500-pound thrust and 5-second duration. Proof tests accomplished with the equipment since November 24, 1953, indicate that with six rockets, using the fixed-panel windshield, ve-

locities of about 420 to 430 miles an hour are possible.

By applying near maximum water-brake force of more than 300,000 pounds, the test sled can be decelerated from 315 miles an hour to 50 miles an hour in a distance of 30 feet, attaining 110G measured on the subject with a rate of onset of over 5,000G per second, and total duration of about 0.1-second. Using the same initial velocity, a steady deceleration of 9-10G has been maintained for 2.7 seconds.

WITH the water-brake decelerator, numerous experiments have been accomplished to explore tolerance and survival limits for deceleration patterns conforming to supersonic escape wind-drag decelerations, for exposure to abrupt onset of windblast at supersonic velocities, and for tumbling during linear deceleration while exposed to high-velocity windblast. These include three human experiments at maximum velocities of 421, 501.8, and 632.0 miles and hour, respectively. From these three human experiments, the following observations were obtained:

In the first experiment, the human volunteer was exposed to an immediate peak force of 22G, at a rate of onset of 600G per second, succeeded by a plateau oscillating at 28 to 30 cycles per second during 0.6-second, around an average of 13G. This oscillation corresponded to the frequency response of the human chest wall.

Exposure to linear decelerative force acting on a subject seated facing forward produced circulatory effects of a mild, transient type, during the 0.6-second of about 13G, corresponding to those previously observed only after several seconds of exposure to similar magnitudes of force attained at about 6G per second on the centrifuge.

The second experiment, during which the subject seated in the forward-facing position sustained exposure to 9 to 10G average plateau for 2.7 seconds, definitely overlapped the time-G minimum plateaus of the human centrifuge. In addition, in this experiment there was abrupt exposure to more than 750 pounds per square foot of windblast pressure with no significant aftereffects.

Above, progressive effect of acceleration in the first 5 seconds of a test ride in which Colonel Stapp was subjected to a force of 12G. Below, initial deceleration caused by lack of thrust after rockets burned out and test sled was entering the water brake. Deceleration force amounted to 22G. In this test a maximum speed of 421 m.p.h. was attained. Later tests exceeded this speed and future ones may eventually carry volunteers to 800 m.p.h., the equivalent of 1,800 m.p.h. at 40,000 feet (Air Force photo).

The third experiment attained 632 miles an hour in order to permit deceleration of more than 25G during more than one second, and exposure to a maximum of 1,108 pounds per square foot of windblast pressure. It attained a practical limit for reversible incapacitation of the subject by decelerative force, with no significant effects due to windblast.

A CLOSED curve of human tolerance for exposure to transversely applied linear forces higher than 20G is postulated on the basis of the following experimental parameters for human subjects:

1. Threshold for impact shock related to rate of change of deceleration: 1,000G per second at 30G for 0.16-second or less of duration.

2. Limit of tolerance for rate of change of deceleration: 1,500G per second at 40G for 1.6-seconds duration or less.

3. Tolerance limit for magnitude of force: 50G attained at 500G per second rate of onset and duration of 0.2-second or less.

4. Duration limit: 1 second for forces averaging 25G or more at 500G per second rate of onset.

Concurrent with the determination of parameters of human tolerance to the effects of linear forces of the second and third derivatives of motion, a new approach to the problem of testing the mechanical components and supporting and restraining the occupants of aircraft has been developed.

Previously it had arbitrarily been assumed that static testing of webbing, attachments, and hardware of crash harnesses and of seat structure correlated adequately with the response of such components to dynamic loads attained under emergency conditions. However, it became apparent after dynamic tests in which emergency conditions were reproduced that static tests fell seriously short of reality.

The dynamic load factor can result in up to double the calculated static load values for abrupt peaks of decelerative force. This has lead to a reëxamination of specification standards and design for inertia reels, harness webbing, attachment hardware, buckles, aircraft seats, and seat attachments.

Defense Highlights: Monthly Review and Outlook

The Army

At last the Army's formidable Redstone missile has been disclosed to the world. The mighty weapon has been developed by Army Ordnance experts and American industry and proved in highly successful tests. The latest addition to the Army's arsenal of atomic-age weapons is reported to have a range of 250 miles. Scientists, engineers, and military specialists evaluate the Redstone missile highly.

Hand in hand with this development is the Army's enthusiasm about its ability to cope with any military problem of the atomic age. This is the view of Wilber M. Brucker, Army Secretary, and Gen. Maxwell D. Taylor, Army Chief of Staff, as presented recently to the Senate Armed Services Committee.

> *"I believe," General Taylor said, "the United States and its allies have the capability, if they have the will, of producing ground forces able to counter the Communist land forces."*

Both witnesses stressed the importance of the Army in the event of war. They emphasized the point that every effort must be made to develop visible military strength in being "which will convince any potential enemy that aggression directed at the free world will fail."

Secretary Brucker and General Taylor underscored the development of new weapons, saying the Army must use a wide range of missiles to carry out its primary mission.

"These missiles, in the final analysis, are artillery projectiles having extended range, accuracy, and lethality," the Secretary explained. "While there still are many problems for us to solve, the Army is enthusiastic about its ability to cope with any problem of the atomic age."

> *He added that the Army is modernizing every part of its equipment and weaponry, as well as its concepts of tactics, strategy, and logistics.*

As for the great numbers of men the Communists could throw into battle, General Taylor said that "quality offsets a simple head count."

While these encouraging reports are being made, Congress seems to be in a mood to take away from the military services the blanket permission they have had since the Korean war to let contracts in certain categories without formally advertised bids. If the attitude persists, such broad exemptions will be granted only when Congress declares an emergency.

A great deal of military buying in recent years was done by direct face-to-face negotiation, not by competitive bidding. The military services regard this as a highly efficient and satisfactory way of doing business especially for noncommercial items of equipment for which exceptional tooling, experience, financial stability, and management are essential.

Such congressional attitudes apparently overlook the long-established fact that lowest bid is not always a guarantee of quality and on-time delivery, particularly when the product happens to be a new weapons system.

The Navy

The Navy has disclosed plans to build the first nuclear-powered submarine capable of firing guided missiles.

Navy officials said that the atomic power plant for the new submarine would cost considerably more than conventional equipment. The submarine, however, would achieve more speed and have a greater cruising range.

Like the atomic submarine NAUTILUS, it would be able to cruise indefinitely beneath the surface at high speeds. In time of war it could surface off enemy coasts, fire its atomic missiles, and submerge quickly.

The Navy already has two conventionally powered submarines capable of launching missiles. Two additional conventional submarines now under construction will be converted to launch guided missiles.

The Talos, a new guided missile, will soon be added to American air and sea defenses. The supersonic missile was developed by the Navy and will be employed in continental air defense in addition to being installed on new Navy guided-missile ships (see page 972).

> *"The missile's range and performance," said the Air Force Chief of Staff, Gen. Nathan F. Twining, "will make it a highly effective defense weapon."*

Talos has been described as a longer-ranging, faster, and more devastating weapon than the Terrier antiaircraft weapon which the Navy already has installed on its first guided-missile cruiser, the BOSTON. Talos, in Greek mythology, was a fabricated brass man given by the god Zeus to the King of Crete to guard that island.

Another missile, designated Tartar, is to be incorporated shortly in the Navy's weapon line-up. This missile is reported to be about three fourths the size of Terrier, but with approximately the same range. It is expected eventually that the antiaircraft gun batteries of all combat ships will be replaced with Tartar missile systems.

Simultaneously Adm. Arleigh A. Burke, Chief of Naval Operations, warned Congress that the Communists are challenging American supremacy on the seas.

He regarded the new menacing development with the utmost seriousness. He asserted that the Communists are building a tremendous and effective

force designed to take over control of the seas.

This grand strategy, Admiral Burke observed, is aimed at the heart of the ability of the free nations to turn back Communist aggression.

"If we are to live up to our collective security agreements," Admiral Burke said, "we must use the seas. If we are to protect our huge overseas investment in men, bases, and stockpiles we must use the seas. If we and our allies are to survive, we must use the seas."

In Admiral Burke's opinion, the Communist naval build-up is the most significant development in their grand strategy since World War II. He expressed confidence in the American Navy's ability to stay ahead.

The Air Force

Gen. Nathan F. Twining, Air Force Chief of Staff, stated recently that he believed American ability to strike back with devastating force makes the United States safe from attack.

"No nation is going to attempt a war with us with the terrific losses he would have to take," General Twining declared.

He said that the United States had a huge stockpile of atomic weapons and the "capability to deliver them."

The Air Force chief also said that the only possibility of an attack would stem from a mistake in judgment about America's military power and its ability to retaliate.

General Twining also testified before a House subcommittee which is considering legislation to place civil defense under the control of the Defense Department. It is now under the jurisdiction of an independent civilian agency.

He took a negative view of the proposal. He opposed it on the ground that, in the event of an enemy attack, the armed forces would be too busy fighting the enemy to have the major responsibility for civil defense.

He amended his statement to say that, in the event of an enemy attack, the Air Force, while not assuming major responsibility, would do what it could to relieve civilian distress.

The Air Force also announced that a $10 million radar system for its Florida guided missile range would soon be completed.

The new radar equipment involves twenty-one installations on eight islands stretching from Florida through the Bahamas and other islands to the South Atlantic.

Pan American World Airways has the prime contract for the operation of the range. The Radio Corporation of America participates as a subcontractor.

The radar units will record and report data back to the flight-control test center in the missile-launching area near Cocoa Beach, Fla.

Missiles will be kept under constant surveillance by the radar units which are automatic and require only one attendant per station.

Atomic Energy

Three developments in the atomic-energy field are commanding national attention. They are (1) the spring tests of atomic weapons, (2) President Eisenhower's authorization of the sale or lease of 44,000 pounds of uranium 235 for the peaceful production of atomic power at home and of the same amount for use by non-Communist countries, and (3) Atomic Energy Commissioner Thomas Murray's plea that the Government inaugurate a $6 billion program to build 12 million kilowatts of atomic power here and abroad by 1965.

1. Adm. Lewis L. Strauss, Chairman of the Atomic Energy Commission, indicated recently that Atomic Energy tests this spring would stress weapons to "blunt the attack against us." He declared that there had been "very great progress" on new weapons and that the tests would help prove new ideas of weapons composition and construction.

Some strategic or offensive-type weapons also will be tested, the admiral declared, but the tests will be concerned mostly with smaller weapons that could be used against invading aircraft or missiles.

When questioned about international efforts to limit the testing of thermonuclear (hydrogen) weapons because of possible radiation damage, Admiral Strauss replied that, had such efforts succeeded, "we would be far behind the point we now are today in diversity and numbers of weapons."

The supposed damage to health that may result, he said, was greatly exaggerated, but in any event "it is a calculated risk that we must take in order that our freedom be preserved."

2. President Eisenhower's plan to sell or lease uranium 235 for the peaceful production of atomic power seems likely to encounter an obstacle in the inability of some underdeveloped nations to finance such a project out of their own funds.

To overcome this obstacle, the Chairman of the AEC favors the creation by our Government of an "atomic financing bank" to help such nations get the peacetime power plants they want.

The proposed release of about 88,000 pounds of uranium 235, on a gradual basis, indicated that the stockpile of American weapons and the rate of current production of fissionable material were adequate to meet foreseeable military demands.

The Commission Chairman cautioned that the plan does not mean that the military stockpile is complete for all future needs.

Assurances will be required that the uranium will not be used for military purposes. Perhaps some form of inspection will be incorporated into the plan. Thus the uranium plan would be an excellent practical test of the inspection theory.

3. Atomic Energy Commissioner Thomas E. Murray wants the United States to assume a commanding lead in the atomic power field. For this reason he wants our Government to appropriate $6 billion to build 12 million kilowatts of atomic power here and abroad by 1965.

In view of Communist capabilities and announced intentions to share peacetime atomic power, Mr. Murray stated that "we have small cause for complacency and much cause for action." At the moment, Mr. Murray said,

"our sweeping promises to the world concerning atomic power are in danger of going by default."

Utilizing Defense Skills

Recent actions in Congress indicate that our legislators would prefer that retired officers sit back with folded hands or go into farming. They would discourage any real effort on the part of such usually highly qualified men to utilize their abilities fully.

In recent hearings before the House Armed Services Subcommittee which has been inquiring into the profits of airplane manufacturers, Representative Herbert made particular note of the retired military officers employed by aircraft companies.

Mr. Herbert expressed the feeling that such officers undoubtedly wielded considerable influence with their former services. His particular target was Fairchild where there are six general officers employed. Mr. Herbert asserted that salaries were "charged against contracts on which the officers did no work."

In rebuttal, Fairchild claimed that retired officers helped recruitment in the armed forces by showing that, after a military career, able officers can command a career in industry.

Last year Congress raised the salary limit under which retired officers may be employed by the Government. Although the increase from three thousand to ten thousand dollars may have seemed generous, the entire philosophy behind such legislation seems most unjust to the able and honest retired officers. It greatly reduces the availability of outstanding personnel that could be available to the Government.

So much for the utilization of skills. As for employment after earned retirement it seems to us decidedly less than fair to limit the earning power of a good and faithful servant.

Technical Manpower

Reënlistment problems that plague the American armed services these days are not unique. They are shared in goodly measure by our British cousins.

There is a growing demand in this country for all types of skilled workmen—factory foremen, mechanics, repairmen, toolmakers, metalworkers, and draftsmen. In our armed services there is a critical shortage of men who are sufficiently competent to keep our aircraft and other complicated atomic-age equipment in good repair and ready for action.

While it is no consolation to us, the British are confronted with the identical lack of technical workers. The 1956 British Statement on Defense contains the following observations:

"Two things are needed to improve the regular structure of the armed forces: (1) to increase the number of recruits and to induce as many recruits as possible to sign on for long engagements, and (2) to persuade those already serving to prolong their service. For the highly technical armed forces of the future we require a substantial proportion of men of long service and experience.

"The problem is urgent. Regular recruiting, which has very largely been of men on short-term engagements, has already fallen from its postwar peak of 100,000 in 1952-1953 to about 62,000 in 1955-1956. In the Navy, extensions and recruitment have declined to such a point that the manning of even the smaller active fleet is becoming more difficult. In the Army and the Air Force, far too high a proportion of men are on 3- to 5-year engagements, and far too few of these men are extending their service."

Students of the problem in our own country, especially those of long experience, are puzzled by the decline of the "dedicated man." Until he returns in all walks of life —military and civilian—the entire social structure, as well as its defense, will be weakened.

At a recent meeting of the American Management Association in Chicago, a prominent industrialist called on industry to help do something about the serious shortages of skilled labor, scientists, engineers, and management talent. He asserted that "our colleges should be raising their standards, and business should coöperate."

If there is a workable solution, someone should come up with it—quick.

The Reserve Program

Military Reserve Week—April 22-28, 1956—focused attention on the new Six-Month Reserve Training Program which was enacted into law by the Reserve Forces Act of 1955. This period was sponsored by the National Security Committee—a group of fifteen patriotic and civic organizations which have banded together to build a more effective military Reserve. Brig. Gen. Harry H. Semmes, Washington, D. C., well-known lawyer, soldier and charter member of the American Ordnance Association, is cochairman of the committee.

During Military Reserve Week, special effort was made to educate the American public regarding the new Six-Month Training Program and its many advantages, not only for our young men but also for American industry and labor.

An all-out effort will be made to strengthen the military Reserve through the increased voluntary enlistment of young men of the 17 to 18½ age group in the Six-Month Program—the one military duty that enables young men to fulfill their military obligations by being full-time civilians and part-time soldiers after six months of required basic training.

The stark necessity of having our young men realize the need of our armed forces under present conditions grows with each passing day. The efforts of the National Security Committee are directed toward emphasis of this need, and in its work the committee will have the unstinted support of every civic and patriotic group worthy of the name.

The American Ordnance Association and this journal in particular have lost no opportunity to stress the need and the advantages of such service. General Semmes, whose latest claim to rightful distinction was his recent superb biography of his friend and wartime commander, General Patton, is setting another example of citizenship at its best.

Time of Defense Decision

An Editorial

OUR defense policies have been the result of a series of compromises. All American citizens worthy of that exalted title want a completely adequate system of national defense—no one wants a seriously impaired or bankrupt civilian economy. The problem in a nutshell is how to achieve the one without incurring the other.

At the moment we Americans are very solicitous about our prosperous economy. We want very much to keep it the way it is. We have no desire to slow down economic progress, or to weaken incentive, by increasing the already heavy tax load. We are striving for a balanced budget. We are not in any great hurry to reduce the enormous national debt. In short, what we desire is business as usual—at a high level of investment, production, employment, and profit.

Since we appear to be having our cake and eating it simultaneously, the big question is whether we can have all this and national security, too. Our immediate reaction is that we can and should have both. Practically speaking, however, we cannot have both on the comfortable terms we have specified. Since we cannot have both, we have been inclined to skimp on national defense in order to maintain business and taxes as usual.

TWO examples of compromises or improvisations that detour around resolute long-range solutions are the Reserve Act of 1955 and the Defense Budget of 1957.

The Reserve Act is not what our expert military planners thought necessary for national defense. It reflects the congressional viewpoint which is, quite naturally, very concerned about a high level of prosperity for the folks back home. Secretary Finucane's article in this issue makes clear the earnest steps the Army is taking to make the act work as Congress desires. (See page 953.)

The defense budget makes deep inroads into our defense readiness by reductions in force—military and civilian alike—which are incomprehensible in the light of ominous signs on the international horizon.

It would scarcely seem to be a policy of wisdom to slash our defense strength while not reducing the global range and magnitude of our far-flung responsibilities and commitments. It would seem to be little less than folly to weaken our defense power at the precise time that the smiling Communists are rapidly building up their predatory and aggressive capacities.

We do not subscribe to the alarmist notion that the intercontinental ballistic missile is "an ultimate weapon" and that we Americans have no defense against it. As Air Force Secretary Donald A. Quarles has pointed out, the Communists have plenty of medium-range bombers and the mere addition of a 1,500-mile missile would not materially affect the balance of power between the Communists and what remains of the free world. Moreover, our B-52 bombers will be capable of doing a better job than anybody can hope to accomplish with missiles of any kind in the near future.

By discounting the highly exaggerated claims being made for the intercontinental ballistic missile, we have no intention of minimizing the growing air strength of the Communists. Gen. Nathan F. Twining, U.S.A.F. Chief of Staff, has warned Congress that the Communist air forces are already much larger than our own and are concentrating attention on research and development programs in order to overcome our shrinking lead in air quality.

CERTAIN national-defense realities are unpleasant and certain economic-financial problems are difficult of solution. But we are not thereby absolved from the intellectual and emotional maturity that are imperative, here and now, for our survival as a nation.

What is called for is neither a New Look nor an Agonizing Reappraisal. Just a plain, ordinary, grass-roots look at the needs of the Army, Navy, and Air Force will do.

There are two atomic-age factors which immediately strike the eye when we turn our attention to national military-naval-air readiness. The first is the time-space factor; the second is the pocketbook factor.

All of us know that we are crowded together in a world that is almost hourly shrinking in size. Any one of us can step aboard an airplane this afternoon and lunch tomorrow in Buenos Aires or Madrid.

A fleet of jet enemy bombers, setting out from, let us say, Obdorsk or Uralsk, could reach the United States with an atomic cargo in an awful hurry. If war comes, we know perfectly well that our success in the really decisive phase will depend on the force we have in being the hour, the minute, the second war starts.

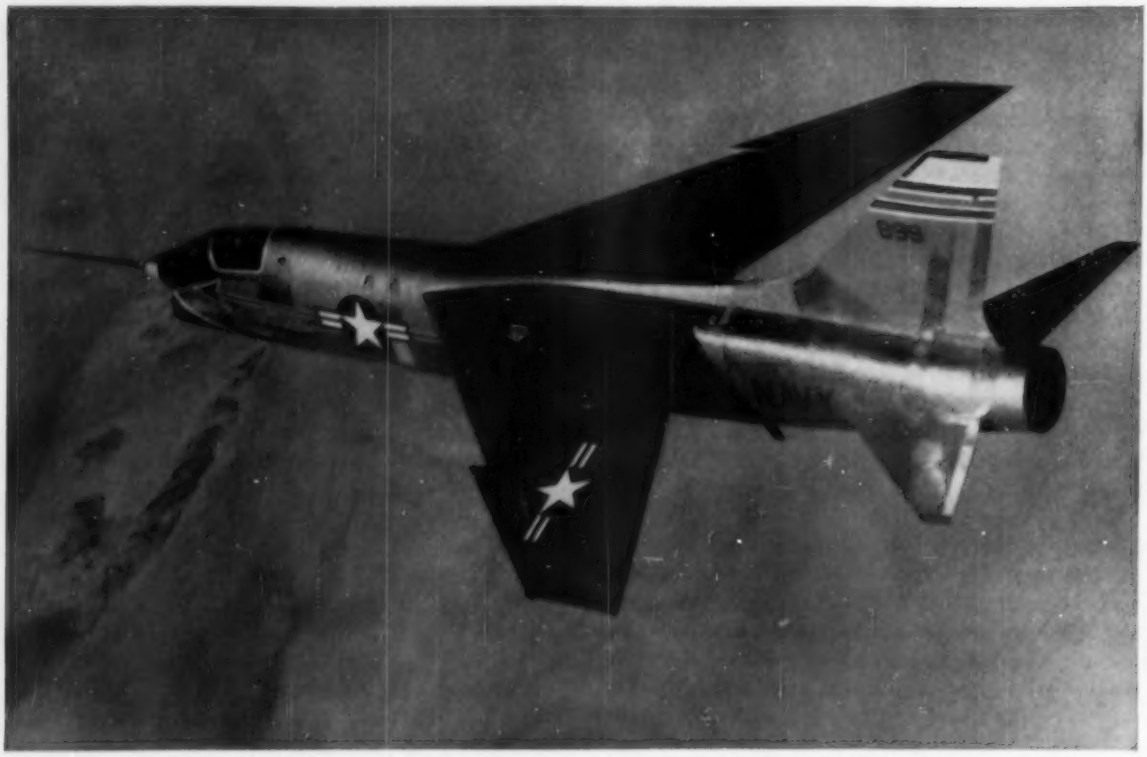
The pocketbook factor simply means that the cost of new atomic weapons is skyrocketing. The nuclear age, by stressing quality rather than quantity, has multiplied the costs of research, development, production, and maintenance to an astronomical degree. All of us will have to pay more for genuine national defense than in the preatomic age.

We are living in a revolutionary era that is profoundly affecting the life and destiny of untold millions of people in all parts of the world. The international scene today is so explosive that we have no other alternative than to be prepared for any untoward eventuality by having on hand the latest and best land-sea-air weapons.

We can neither buy time nor control the dynamic evolution of world history. What we can do is to avoid the colossal stupidity of last-minute brink-of-war appropriations for defense purposes that will never give us the strength either to maintain today's fretful peace or, if necessary, to fight a successful war in defense of our national interests.

This is indeed a time of defense decision!

New Fighter Aircraft



The Navy's new Chance Vought F8U-1 Crusader supersonic jet fighter, above, has thin sweptback wings and tail surfaces. The new North American Super Sabre F-100D, below, is guided automatically to its target. It is the first Air Force fighter-bomber to exceed the speed of sound in level flight, and a previous model set a world speed record of 822 m.p.h.

ASSOCIATION AFFAIRS

Hon. Frank H. Higgins Is Guest of Honor at Capital Cities Post Meeting

The Hon. Frank H. Higgins, Assistant Secretary of the Army (Logistics), was the guest of honor and principal speaker at the winter dinner meeting of the Capital Cities Post on February 8, 1956. The Secretary spoke on the Army supply system and described with clarity and conviction the programs and policies now governing that important operation.

More than 300 members of the Post were on hand at the Edison Club, Schenectady, to hear Secretary Higgins' address and to applaud the prudence of his views.

The toastmaster was E. B. Doherty, Post president and president of the National City Bank of Troy, N. Y. Harry L. Erlicher, until recently production adviser in the Office of the Under Secretary of the Army at Washington, was among those cited by Secretary Higgins for his valued contribution to the Korean war effort and the following period. Mr. Erlicher was for more than fifty years associated with the General Electric Company and now resides at his home in Schenectady.

Vice Adm. Willard A. Kitts, 3rd, was presented a testimonial certificate in recognition of his services to the Association as chairman of the A.O.A. Underwater Ordnance Division. Admiral Kitts was formerly Assistant to the Chief of the Navy Bureau of Ordnance and is now an official of the General Electric Company.

The program chairman, Arthur B. Gregg, Jr., had invited an array of military and industrial leaders in the Capital Cities area. Leading this delegation were: Brig. Gen. Victor J. MacLaughlin, commanding general, Schenectady General Depot; Col. E. S. Mathews, commanding officer, Watervliet Arsenal; and Maj. Gen. H. R. Westphalinger, director of procurement, Army General Staff.

The current activities of the Ordnance Association were described by Col. Leo A. Codd, executive vice-president at A.O.A. national headquarters.

The officers of the Capital Cities Post for the current year are: Mr. Doherty, president; Colonel Mathews, first vice-president; E. D. Rhodes, immediate past president. Mr. Erlicher represents the Post on the national Council of the Association.

The chairmen of standing committees are: J. O. Amstuz, Industrial Preparedness; J. S. Wyld, Public Information; Mr. Gregg, Meetings and Programs; E. S. Webster, Membership; and A. A. K. Booth, Student Activities. Mr. Webster is also a director of the Post and was one of its founders and most active proponents.

At Capital Cities Post meeting were, seated left to right: Post President E. B. Doherty; the Hon. Frank H. Higgins, Assistant Secretary of the Army; Brig. Gen. V. J. MacLaughlin, Schenectady General Depot. Standing, left to right: Vice Adm. W. A. Kitts, 3rd; J. S. Wyld; and Col. E. S. Mathews, Watervliet Arsenal.

Yankee Post Members Hear Discussion of Offensive and Defensive Aspects of Missiles

The members of the Yankee Post were treated to the offensive and defensive aspects of missiles at their winter meeting on February 2nd at the Walker Memorial at Massachusetts Institute of Technology. The crowd of over 300 gathered early to inspect the Memorial, M.I.T.'s student union building, which had not been used before by other than the institute's own organizations.

Following the reception and dinner, Post President M. Edgar Fain, Tower Iron Works, Providence, R. I., introduced Dr. Albert G. Hill, professor of physics at M.I.T., and presented to him the Yankee Post Distinguished Service Award in recognition of his outstanding leadership while director of Project Lincoln.

Dr. Hill then described some of the problems that had to be solved in developing the air defense system of North America, the task for which Project Lincoln was established. He also made it clear that air defense was an endless problem requiring continual reworking to keep pace with faster aircraft and increasingly longer range missiles.

Rear Adm. M. F. Schoeffel, director of weapons planning, General Precision Equipment Corporation, and formerly Chief of the Navy's Bureau of Ordnance, discussed ballistic missiles. The admiral noted the many engineering problems to be solved before a ballistic missile can become an effective and satisfactory weapon.

• **AT ALBUQUERQUE.**—The Post held its annual meeting at the Kirtland Air Force Base Officers' Club on Thursday, February 9th. Many distinguished citizens of the community and A.O.A.

members from industry and the armed services were on hand to celebrate the Post's first formal dinner meeting.

Hon. E. M. Zuckert, former AEC Commissioner, the guest of honor, was introduced by Col. Charles Begg of the Special Weapons Center, Post president. Mr. Zuckert in speaking on "Civilian Uses of Atomic Energy" praised the recent panel headed by Robert McKinney that reported to Congress on the impact of the peaceful uses of atomic energy. He noted particularly the realism embodied in the report and the sensible recommendations for setting a bold and clear program.

He explained that the great share of the cost burden for atomic power must be willingly shared by the Government because industry's expenditures must be related to profits; yet progress in the peaceful atomic-energy field is a vital element of our standing in the free world.

Large Turnout of Members Attends Aberdeen Post Meeting in Baltimore

The Aberdeen Post held its annual dinner meeting at the Sheraton-Belvedere Hotel, Baltimore, Md., on Tuesday, March 6th. Many distinguished citizens of Baltimore and a large turnout of members from industry and the proving ground crowded into the grand ballroom for this occasion.

T. F. Naylor, Post president, presided, and Col. John J. Wood, Chaplain, Air Research and Development Command, delivered the invocation.

The guests were welcomed to Baltimore by Mayor Thomas D'Alesandro, Jr., after which Mr. Naylor turned the meeting over to Toastmaster Jess W. Sweetser, vice-president, Glenn L. Martin Company, who introduced Col. Leo A. Codd, executive vice-president of the Association.

Colonel Codd read the preamble of the A.O.A. constitution and paid special tribute to Maj. Gen. J. L. Holman, commanding general of Aberdeen Proving Ground; Mark S. Watson, military correspondent of the *Baltimore Sun;* and Mr. Naylor. To the latter he presented a certificate of appreciation for his outstanding contribution as chairman of the Rocket Committee of the Guided Missile Division.

The guest of honor and principal speaker was Maj. Gen. Floyd B. Wood, Deputy Commander for Research and Development, Air Research and Development Command. General Wood spoke on the trend of technical progress which he defined as man's ability to perceive and change his environment to meet his needs.

Through a series of charts he displayed the accelerated rise of this country's present requirements, factory and home construction, population, and gross national production.

He pointed out the close relationship between the foregoing advances and technical progress. Scientific achievement is in effect a chain-reaction process in that for each new development or discovery one or more additional problems arise that require a solution. Based on this background, the general pointed out that unless we would have stagnation, research programs must be supported at their material rate of growth which must follow the average exponential curve of all elements that contribute to the growth of a country.

(General Wood was killed in an airplane accident near Baltimore, Md., on April 3rd.—Ed.)

Before and after the meeting members were discussing the coming national Annual Meeting at Aberdeen Proving Ground in October 1956. It is evident that enthusiasm is already riding high, and the meeting promises to be one of the most spectacular in many years.

In addition to dignitaries previously mentioned, guests at the speakers' table were: Alexander N. Aird, Revere Copper & Brass Inc., Baltimore; Richard S. Boutelle, Fairchild Engine and Airplane Corporation, Hagerstown, Md.; Rear Adm. W. E. Cleaves, Bendix Radio Division of Bendix Aviation Corporation, Baltimore; Thomas F. Colleran, Development and Proof Services, Aberdeen Proving Ground; Brig. Gen. Marvin C. Demler, Assistant Deputy Commander, Research and Development, Air Research and Development Command, Baltimore; F. W. Godsey, Jr., Westinghouse Electric Corporation, Baltimore.

Also at the speakers' table were: Brig. Gen. David N. Hauseman, Davison Chemical Company, Baltimore; Maj. Gen. J. H. Hinrichs, Deputy Chief of Ordnance, U. S. Army, Washington, D. C.; Joel M. Jacobson, Aircraft Armaments, Inc., Cockeysville, Md.; Capt. Kenneth P. Letts, U.S.N., commanding officer, Service School Command, Naval Training Center, Bainbridge, Md.; Walter F. Perkins, Koppers Company, Inc., Baltimore; Robert E. Perry, Kaiser Aluminum & Chemical Corporation, Halethorpe, Md.

Also at the head table were: Maj. Gen. John W. Sessums, Jr., Vice Commander, Air Research and Development Command, Baltimore; Col. Stephen E. Smith, Corps of Engineers, Baltimore; H. C. Townsend, Western Electric Company, Baltimore; Richard H. Turk, Pemco Corporation, Baltimore; Brig. Gen. Thomas K. Vincent, staff consultant, A.O.A. Technical Divisions and Committees, Washington, D. C.; Capt. J. M. P. Wright, U.S.N. (Ret.), staff consultant, A.O.A. Post operations, Washington, D. C.; and E. E. Yaggy, Gerotor May Corporation, Baltimore.

T. F. Naylor, right, Aberdeen Post president, receives A.O.A. certificate of appreciation from Col. Leo A. Codd, executive vice-president of the Association.

• **AT DALLAS.**—The Lone Star Post was host to Maj. Gen. Floyd B. Wood, late Deputy Commander, Air Research and

Development Command, on February 29th at the Statler-Hilton Hotel, Dallas, Tex.

Members and guests from all parts of Texas were in attendance for the reception, dinner, and meeting. The presiding officer, Post President I. Nevin Palley of Temco Aircraft Corporation, welcomed the distinguished guests, described the aims of the A.O.A., and then introduced General Wood.

General Wood's talk was based on the long-term experience that lies behind the present tremendous acceleration of research and development. He stressed the need for increasing both financial and educational support to maintain the rate of new developments.

Rio Grande Post Members Welcome General Laidlaw to Command of White Sands Proving Ground

The Rio Grande Post met at the Town and Country Inn, Las Cruces, N. Mex., on Tuesday, March 6th, to welcome Gen. W. E. Laidlaw, new commanding general of White Sands Proving Ground, and to hear Dr. H. E. Newell, Jr., U. S. Director of the International Geophysical Year.

Herbert L. Karsch, a vice-president of the Post and assistant for engineering at White Sands, presided in place of Brig. Gen. L. I. Davis, acting president. The meeting opened by a reading of the preamble to the A.O.A. constitution by Lieut. Col. J. P. Hamill.

General Laidlaw was introduced to the Post and expressed his pleasure at having his first opportunity to greet many of the citizens of the Rio Grande area. The guest speaker, Dr. Newell, who is attached to the Naval Research Laboratory in Washington, D. C., revealed in his talk that many of the two to three hundred high-altitude test rockets to be fired during the 1957 Geophysical Year will be launched from White Sands.

He then outlined the types of studies to be carried out throughout the world during this year of concentrated international scientific study and touched briefly on the plans for globe-circling satellites to be launched from Patrick Air Force Base in Florida. He expressed the hope that rockets would reach new altitudes up to 300 kilometers.

Post officers and other guests at the speakers' table were: R. W. Benfer, manager, Bell Telephone Laboratories crew at White Sands; J. R. Pernice, NATO Advisory Council in Paris, France; Capt. Levering Smith, commander of the White Sands Naval Facility; Chris P. Fox, State National Bank, El Paso; Rupert Chisholm, Atlas Lumber Company, Las Cruces; Col. B. J. L. Hirshorn, deputy for technical operations, White Sands; Col. H. O. Nelli, U. S. Army (Ret.), Chambersburg, Pa.; and Col. Sylvester A. Hall, Post Ordnance Officer, Fort Bliss.

Huntsville Chapter of Birmingham Post Welcomes General Medaris

At Huntsville, Ala., on the edge of Redstone Arsenal, the recently organized Huntsville Chapter of the Birmingham Post held its first formal meeting on February 17th.

Members and guests numbering about 200 gathered at the Russell Erskine Hotel to greet Maj. Gen. John B. Medaris, commanding general, Army Ballistic Missile Agency. The meeting was in effect a welcome to General Medaris who was making his first public appearance after assuming command of the new agency a few weeks before.

After receiving reports from activity chairmen, the presiding officer, Chapter president J. A. Muller, Redstone Arsenal, introduced the guest of honor.

General Medaris paid tribute to the team of scientists who developed the Redstone missile and asked for the continued support of the citizens of Huntsville in cementing the close bonds with Redstone Arsenal.

The general then elaborated on the rôles of Army Ordnance and industry in designing and producing superior weapons. He emphasized that Army Ordnance could not relinquish its final responsibility for weapons yet it required the full backing of industry in both development and production.

At Huntsville Chapter meeting were, left to right: W. A. Lewis, program chairman; J. D. Darwin, secretary-treasurer; Brig. Gen. H. H. Toftoy, commanding general, Redstone Arsenal; Maj. Gen. J. B. Medaris, guest of honor; T. D. Johnson, membership chairman; and J. A. Muller, president of the Huntsville Chapter.

Washington Post Hears Admiral Clark and J. B. Macauley at Two Meetings

The Washington Post held its monthly luncheon meeting at the Army-Navy Country Club on Thursday, February 16th, to welcome Rear Adm. John E. Clark, new Assistant Director of Guided Missiles, Office, Chief of Naval Operations.

The presiding officer and Post president, George M. Riveire, introduced the Post officers and directors at the speakers' table and the following distinguished guests: Maj. Gen. J. H. Hinrichs, Deputy Chief of Army Ordnance; Rear Adm. W. A. Schoech, Assistant Chief for Research, Navy Bureau of Aëronautics; Rear Adm. Dawson Bennett; Col. Robert E. Good, Office of Information, Air Force Headquarters; Capt. Richard Lane, U.S.N., Office of Information, Navy Department.

Admiral Clark gave his views on the steps needed to ensure effective missiles. He stressed the need for simple and rugged engineering so that missiles will function satisfactorily under the combined wartime duress of mass production with watered-down manufacturing skills and rough handling in the field.

The admiral stated that the Industry-Ordnance Team should concentrate on simplicity, standardization, specification, substitution, and "sacrilization." The last word was defined as meaning the need for management and engineering to "get religion" in production design and in ac-

quiring a firsthand knowledge in utilization of the weapon.

At the Post's monthly luncheon meeting on March 15th, the guest speaker was J. B. Macauley, Deputy Assistant Secretary of Defense for Research and Development. The growing interest of Washington Post members in their Association was indicated by a record turnout of over 325 members and guests who packed the facilities of the Army-Navy Country Club.

Mr. Macauley spoke on the guided-missile situation. He pointed out our increasing supply of operational missiles that provided a growing capability to our over-all national defense and noted that in considering the needs of this country we must not place them entirely on a comparative basis. In missiles, particularly, he said it is meaningless to compare numbers and types.

He answered many of the questions now circulating regarding the intermediate and continental ballistic missile programs. There was doubt that any one had completed and fired a ballistic missile with useful payload and accuracy. The solution of development problems on a 70-hour-week basis was not realistic; however, 3-shift work on tests of propulsion structures and materials were carried on frequently. A crash program similar to the Manhattan Project seems nonprofitable as we have a 10-year backlog of experience in missiles whereas there was almost none in atomic weapons, Mr. Macauley indicated.

Dr. Newell repeated Secretary of the Air Force D. A. Quarles' statement to the effect that we can expect our air-breathing missiles such as Navaho and Snark to be more than a match for any crash-program ICBM for several years in the future.

At the speakers' table in addition to the Post officers were: Deputy Assistant Secretary of the Army Henry N. Marsh; Maj. Gen. J. H. Hinrichs, Deputy Chief of Ordnance; William H. Martin, Director of Research and Development for the Army; Alfred G. Waggoner, Committee on Aëronautics, Department of Defense; Capt. Robert L. Taylor, U.S.N., program director for missile development, Navy Bureau of Ordnance; and Dr. H. G. Stever, chief scientist to the Chief of Staff, U.S.A.F.

Tri-Cities Chapter of Empire Post Hears Colonel Bellavance Speak at Johnson City Meeting

Over fifty members and guests of the Tri-Cities Chapter, Empire Post, met at the American Legion Clubhouse, Johnson City, N. Y., on March 1st.

After the dinner meeting at which John H. Bouman, Chapter chairman, presided, Lieut. Col. Armand L. Bellavance, chief of manufacturing at Watervliet Arsenal, spoke on "World Affairs and Their Effect on Ordnance." From his service in World War II in the European theater and a tour of duty in Iran after the war,

Lieut. Col. Armand L. Bellavance

he gave many interesting examples of the effect of any incident on the policies and programming of our own national defense even down to the Ordnance Corps.

After the colonel's talk, Maj. A. J. Skotnicki of the local Marine Corps Reserve presented excellent films on Soviet Army training and the use of radar in air-to-ground liaison in Marine air wings. The major has been most generous of his time and effort in procuring timely films with which to keep the membership abreast of current happenings in the armed services.

• **MAJ. GEN. WILLIAM LEWIS BELL, JR.**, a distinguished Ordnance officer, died at Washington, D. C., March 19, 1956. He was Assistant Chief of Ordnance and chief of the Research and Development Division, Office Chief of Ordnance, United States Army, Washington, D. C.

General Bell was born in Norfolk, Va., on June 5, 1904, and spent his boyhood in Richmond. He attended Hampden-Sydney College prior to entering the United States Military Academy from which he graduated in 1929. He was commissioned in the infantry, and after attending the Ordnance School and the Massachusetts Institute of Technology he transferred to the Ordnance Corps.

He served at the Picatinny Arsenal, Springfield Armory, Aberdeen Proving Ground, and Watertown Arsenal. In 1938 he was assigned to the Military Academy as an instructor in ordnance and gunnery.

During World War II he was Ordnance Officer of the China-Burma-India Theater. He served with the Ordnance Board and the Ammunition Division, Office, Chief of Ordnance.

He commanded Picatinny Arsenal in 1953-1954, after three years with the Atomic Energy Commission. He was promoted to brigadier general in 1954 and assumed command of White Sands Proving Ground later in the same year.

Here his deep interest in the Ordnance Association was reflected in the undertaking that he directed to move the Rio Grande Post headquarters from El Paso to White Sands. His long-standing enthusiasm for A.O.A. affairs engendered a spontaneous reaction in the Rio Grande area that more than tripled the Post membership. General Bell served as president of the revived Rio Grande Post until he was transferred to the Office of the Chief of Ordnance in Washington.

He was a valiant officer, a most talented engineer, and a worthy successor to the long line of scientists and ballisticians who have led the forces of Army Ordnance.

C. L. Eksergian, chairman of the Association's Guided Missile and Rocket Division, in a message of condolence to Mrs. Bell expressed for the members of the Division as well as for the entire Association the sentiments of esteem in which General Bell was held:

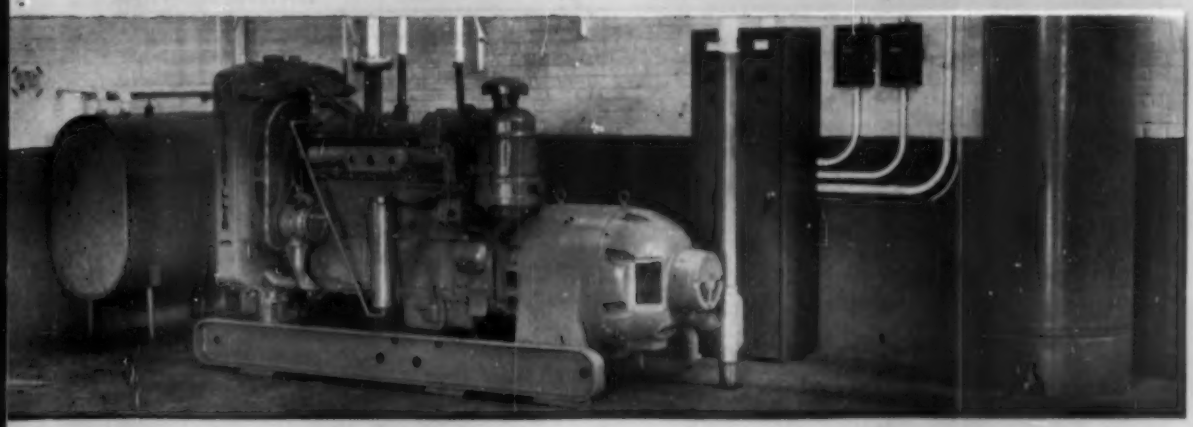
"He won the admiration and esteem of each and every one of us. His sincere spirit of coöperation in effecting, through this organization, a closer relationship between the Army and industry, constituted a notable benefit to our Nation.

"But of equal, if not greater moment, his patient and sympathetic attitude not only endeared him to each and every one of us who were privileged to know him, but served as an inspiration and stimulus to our efforts in which he was such an outstanding contributor."

General Bell entered upon the duty of Assistant Chief of Ordnance in 1955 and was promoted to major general on March 16, 1956. His decorations included the Legion of Merit, the Bronze Star, and the Commendation Ribbon.

General Bell was buried at West Point, N. Y., on March 23, 1956.

• **JOHN HERBERT VAN DEVENTER**, one of the first organizers of the Ordnance Association, and a nationally known journalist and editor, died at his home on Peach Lake, Brewster, N. Y., March 5, 1956. The editors of this maga-



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zine record their great indebtedness to him for his pioneer work in the establishment of the organization and the planning of its magazine in its formative days. He served with distinction as an officer in the Ordnance Department of the Army during the First World War.

Major Van Deventer was graduated from Sibley College with an engineering degree in 1903. He became associate editor of *American Machinist* magazine in 1915 and two years later became its editor.

In 1917 he took leave of absence from his editorial responsibilities and was assigned to active military duty with the Technical Staff of the Ordnance Department. It was during this service that he became impressed with the need for a permanent membership society of American citizens in keeping alive in time of peace the art of armament design and production. He served as secretary of the organizing committee of what soon became the Army Ordnance Association in October 1919. He also assisted in planning the publication of the first issue of this magazine of which the first editor was the late Col. James L. Walsh.

Following his return to civilian life in 1918, Major Van Deventer edited a number of industrial engineering journals and was a consulting editor for the McGraw-Hill Publishing Company in whose plant the first issue of ARMY ORDNANCE was actually printed. He was editor of *Iron Age* from 1930 to 1946 and later became president of the Iron Age Publishing Company.

Well-known as a public speaker and industrial engineer, Major Van Deventer was an energetic advocate of economic research. He was chairman of information for the Committee for Economic Development from 1947 to 1949.

The editorial staff of ORDNANCE records here heartfelt acknowledgment of this journal's debt to an officer and gentleman who, by his inspiration and industry, helped bring this magazine into being. May it ever be faithful to his high ideals of patriotism and national security.—L. A. C.

• **JOHN M. SYLVESTER**, general manager of the Bethlehem, Pa., plant of Bethlehem Steel Company since 1945, and long a member of the American Ordnance Association, died on Tuesday, February 28, 1956.

Mr. Sylvester, a native of Washington, D. C., and an alumnus of the United States Naval Academy, Class of 1911, became employed by Bethlehem Steel in 1914. He was appointed assistant manager of the Bethlehem plant in 1936 and manager in 1945. Under his leadership the plant increased its ingot capacity by forty per cent, adjusted successfully to the technological demands of World War II and the postwar period, and achieved a notable record in industrial safety.

Mr. Sylvester was also a member of the American Society for Metals, the American Iron & Steel Institute, the Newcomen Society, and the U. S. Navy Alumni Association.

• **O. POMEROY ROBINSON, JR.**, senior vice-president, General Dynamics Corporation, died at Lawrence Memorial Hospital, New London, Conn., on February 27, 1956.

Mr. Robinson, a well-known member of the American Ordnance Association, was manager of the Electric Boat Company, a branch of General Dynamics Corporation, during the construction of the NAUTILUS, first U. S. nuclear submarine.

During World War II he was responsible to a great degree for the outstanding production record of eighty-two submarines built by the Electric Boat plant at Groton, Conn. He was a leader in civic and professional affairs, serving many local and national organizations including the Shipbuilders' Council of America, the Newcomen Society in North America, the Society of Naval Architects and Marine Engineers, as well as the American Ordnance Association.

Nonferrous Metallurgy Committee, Advisory, Technical and Research Group, Meets at Dahlgren

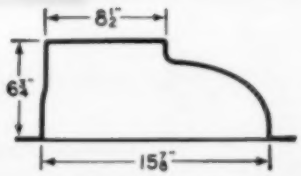
The Nonferrous Metallurgy Committee, Advisory, Technical, and Research Group, met at the U. S. Naval Proving Ground, Dahlgren, Va., on January 18, 1956. Leslie A. Ward, Chase Brass & Copper Company, chairman of the Committee, presided. The group was taken by Navy bus from the Main Navy Building, Washington, to the proving ground.

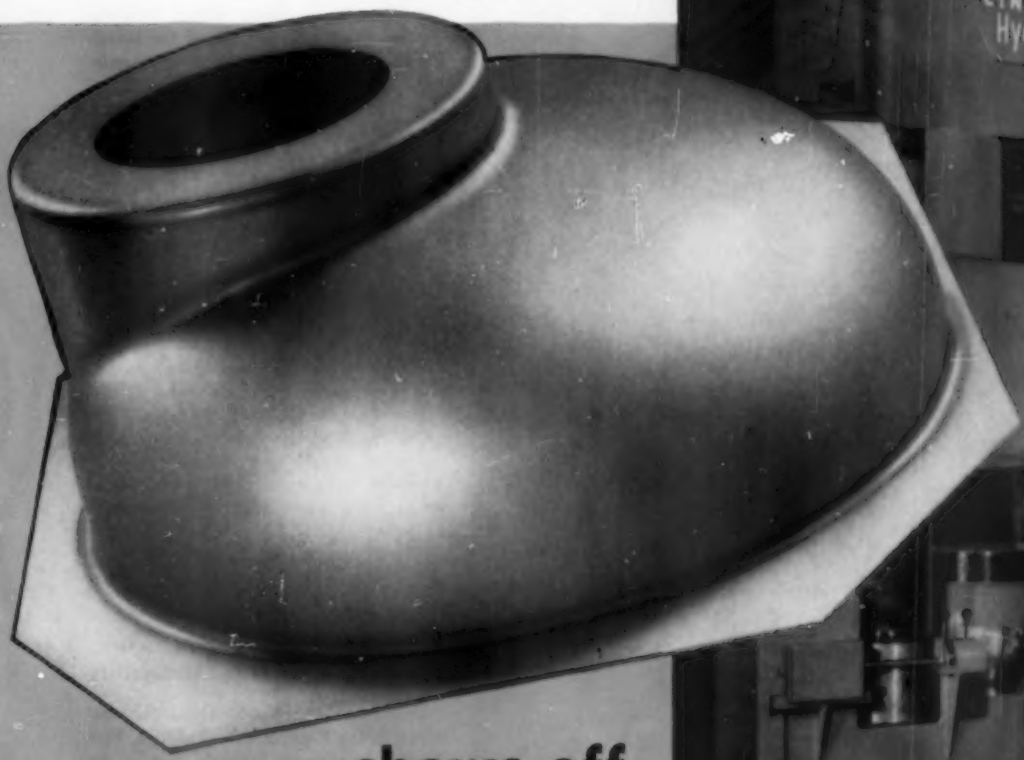
Capt. J. F. Byrne, U.S.N., commander of the proving ground, opened the session with a brief discussion stressing the importance of work being done at Dahlgren and how it had been called upon to take care of the greatly increased work load caused by the several recent wars and emergencies, even though limitations of space for ranges offered severe handicaps at times.

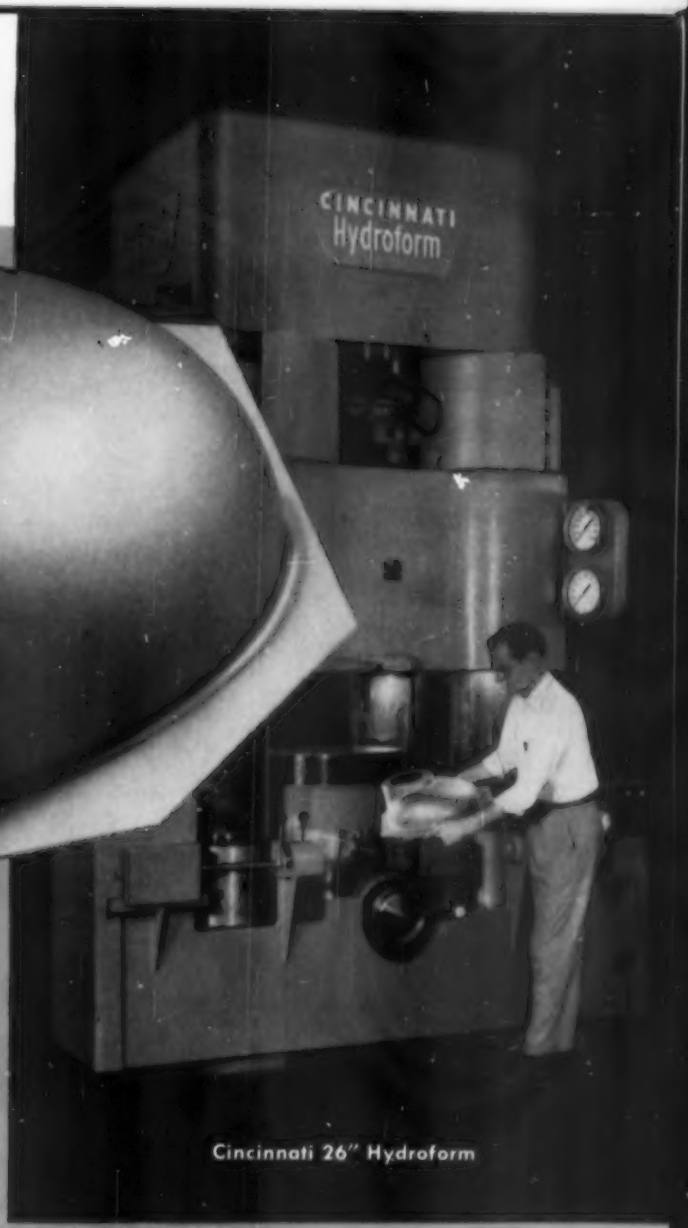
Brig. Gen. T. K. Vincent, from A.O.A. headquarters, discussed the increasingly important functions which were assumed by the Technical Committees of the Association and their growth in stature.

He emphasized the need for Committees to stick to technical matters, which was to be brought to the Committees' attention by a public reading, before each meeting, of the section of the by-laws which proscribed certain activities.

Material: .040"
Type 302 stainless steel







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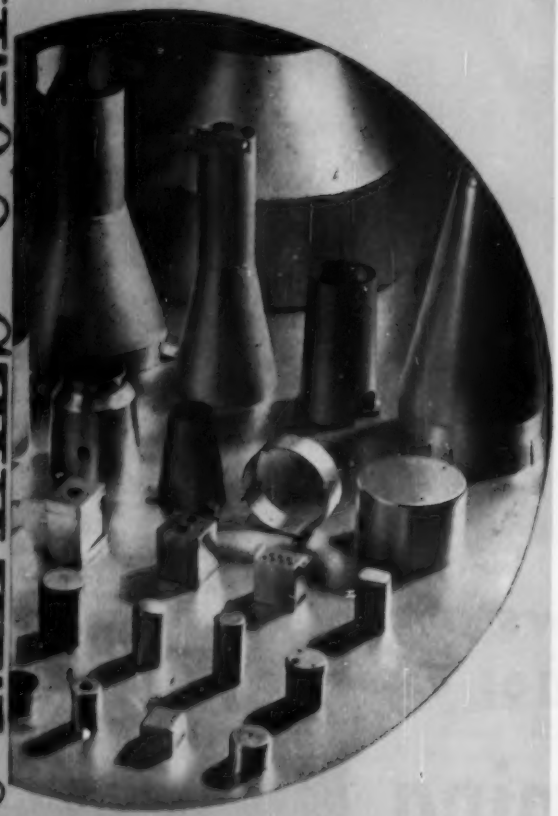

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Division Activities

Dr. R. H. Lyddane, Naval Proving Ground, discussed the work of the Naval Proving Ground on rotating bands.

C. R. Felmley, Air Reduction Company, representing the A.O.A. Welding Committee, discussed welded overlay rotating bands from the industry research point of view.

I. G. Betz, Frankford Arsenal, discussed welded overlay rotating bands as developed in the Pitman-Dunn Laboratories.

A general discussion closed the morning session. After luncheon at the Officers' Club the Committee was taken on a conducted tour of the proving ground, visiting several unclassified areas.

The meeting was very successful, and the exchange of information on the application of nonferrous metallurgy techniques to the rotating-band problems of the services was mutually profitable.

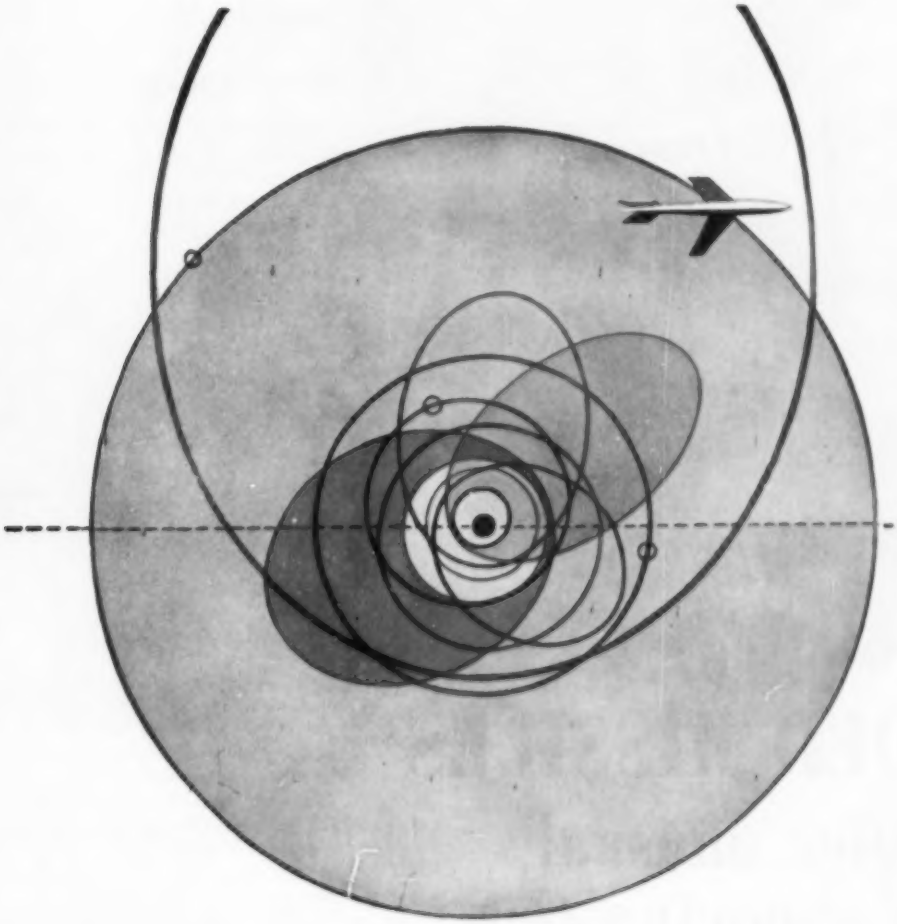
Electronic Components Group Meets in Pentagon To Discuss Research and Reliability

The Electronic Components Subcommittee of the Electronics Committee, Fire Control Instrument Division, met in the auditorium of the Pentagon on February 10, 1956, under the chairmanship of P. S. Darnell, director of component development, Bell Telephone Laboratories, Whippany, N. J.

The general theme of the meeting was "Research To Improve Reliability of Electronic Components." Before getting into the formal program, Brig. Gen. T. K. Vincent, A.O.A. staff consultant for Technical Divisions and Committees, welcomed the group and discussed the organization and operations of the technical activities of the A.O.A. He closed by reading a portion of the preamble of the A.O.A. constitution and of the statement of policies and procedures governing the operation of Technical Divisions and Committees, as required by executive action.

Chairman Darnell discussed the dominant theme of the meeting and set the pattern for the discussions which were to follow. All sessions were open and no classified matter was discussed.

During the morning session, at which about 200 persons were present, papers were presented by R. H. DeWitt, Office, Assistant Secretary of Defense for Applications Engineering, on the subject of "The Constitution and Operation of the Advisory Group Reliability Electronic Equipment (AGREE) as it Relates to



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COMPONENT EVALUATION

Association Affairs

Division Activities

Applications Engineering"; Maj. Gen. John H. Hinrichs, Deputy Chief of Army Ordnance, on "Reliability and Its Importance to Ordnance Matériel"; and F. J. Given, vice-president, Sandia Corporation, on "Appraisal of the Problem of Future Research." After these papers were presented, a short discussion period was held.

After lunch about one hundred persons assembled for the afternoon session. Five papers were presented by industry representatives which covered several phases of the reliability problem from the industry viewpoint. These papers were by:

Clifford Eddison, head of chemical and physical laboratories, Radio Corporation of America, on the subject of "Relationship of Materials and Processes to Reliability"; Carroll G. Killen, manager, field engineering department, Sprague Electric Company, on "Engineering Aspects of Electronic Component Reliability"; R. E. Moe, manager of engineering, receiving tubes, General Electric Company, on "Research for Reliability in Electron Tubes"; J. L. Pfeffer, assistant general manager, Struthers-Dunn Company, on "A Relay Manufacturer's Approach to Increasing Demands for Reliability"; and R. M. Ryder, transistor development engineer, Bell Telephone Laboratories, on the subject of "Research for Reliability in Solid State Devices."

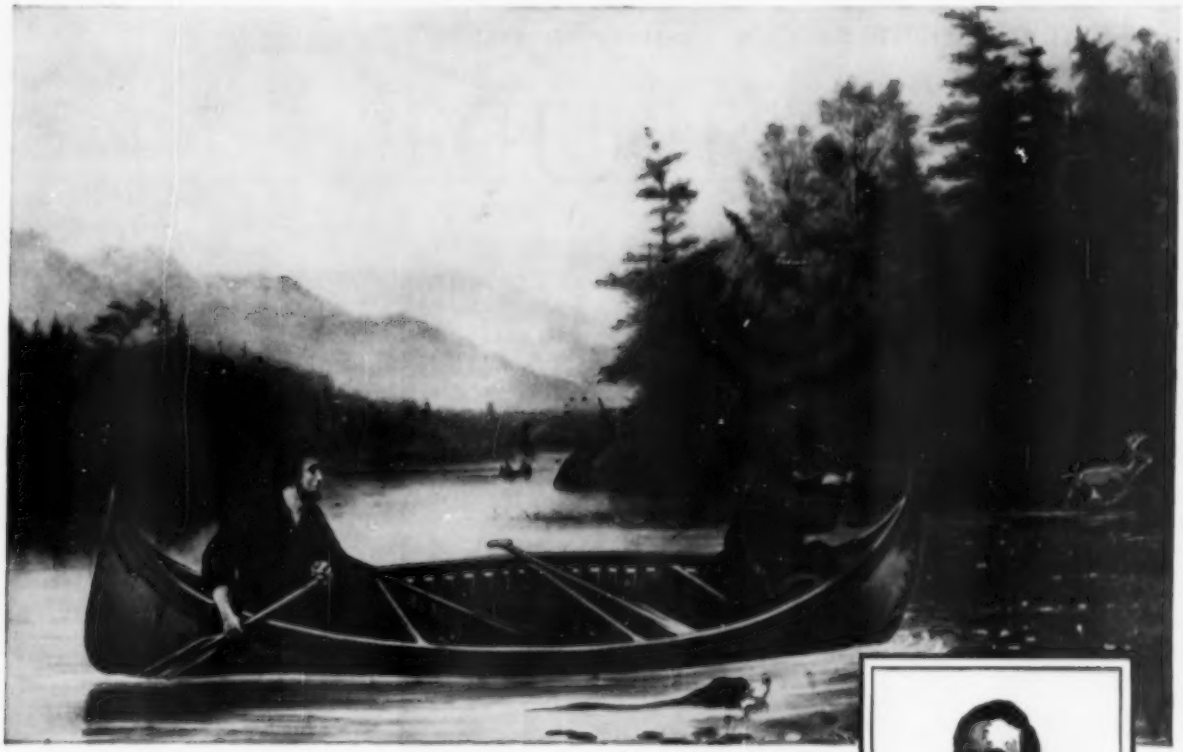
A short discussion period after these presentations disclosed the magnitude of the reliability problem as well as the progress being made slowly and carefully toward an ultimate solution.

This was an excellent meeting, well organized and presented. Thanks and commendations are due Mr. Darnell, and Henry Handler, Office, Chief of Ordnance, who handled all details in the Washington area.

Loading Committee, Bomb and Artillery Ammunition Division, Meets at Joliet Arsenal

The Loading Committee of the Bomb and Artillery Ammunition Division met at the Joliet Arsenal, Joliet, Ill., on February 16-17, 1956. This Committee has two cochairmen, Brig. Gen. J. G. Holmes, Mason & Hanger-Silas Mason Company, Iowa Ordnance Plant, and H. S. van Buren, Procter & Gamble Company, each of whom conducted sessions of the meeting.

Parts of the preamble to the A.O.A. constitution and the statement of policies and procedures governing the activities of A.O.A. Technical Divisions and Com-



Hunting—and the Man Who Had a Name to Live up to

Young brother of Gen. George Rogers Clark, William Clark carved a man-sized niche for himself among America's greats. While only 22, this tough frontiersman helped put down Indian uprisings in the Ohio Territory. Then came 1806 and his chief claim to fame: blazing a trail with Lewis all the way to the Pacific Ocean—the first expedition to cross the U.S.

Naturally, hunting was a necessity in Clark's way of life: "We saw 37 deer on the banks and in the rivers today, 5 of which we killed"; "I killed a very large and the whitest woolf I have ever seen." Still, accounts by contemporaries show that the hunt was also his favorite pastime: "Captain Clark hunted with the Indians and shot 10 buffalo" and "Captain Clark this evening killed one Elk & a deer." Hunting was in the man's blood—and in his heart.

Since pre-Revolutionary days, Americans from all walks of life have enjoyed the thrills only hunting can provide. It's a sport that challenges wits, reflexes, stamina and skill. Equally important, hunting helps build self-reliance and endurance . . . a valuable contribution to the nation's well-being.

Today, the great American tradition of hunting can be perpetuated only by thoughtful preservation of wildlife. Throughout the country hunting associations are cooperating with public agencies to promote proper conservation. Do your part in preserving this heritage—join or support one of these groups now. E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Delaware.

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Division Activities

mittees were read by General Holmes in opening the meeting. This is a recommended procedure which was approved by Louis Polk, vice-president in charge of A.O.A. Technical Divisions and Committees, at the last annual Executive Board meeting.

Lieut. Col. Joseph F. Greene, commanding officer of Joliet Arsenal, welcomed the Committee and placed the facilities and personnel of the arsenal at its disposal for the purposes of the meeting.

R. L. Telford, Mason & Hanger-Silas Mason Company, Bomb and Artillery Ammunition Division chairman, paid tribute to the Committee and its fine work.

Brig. Gen. Robert G. Butler, commanding general, Ordnance Ammunition Command, informed the Committee of future planning for the loading plants and the shift of emphasis to guided missiles.

Col. J. P. Harris, Ordnance Corps, American Safety Razor Company, who has been a consultant to the Foreign Aid Operations of the Department of Defense, gave an excellent talk on the group's work in Europe.

Col. O. M. Jank, Day & Zimmerman, Inc., Lone Star Ordnance Plant, gave papers on "The Cold Solids Method of Preparing TNT for the Filling of High-explosive Projectiles," and "Production of Supplementary Charges by the Casting Method."

J. G. Martis, operations division, Joliet Arsenal, discussed "Development of Automatic Loading Equipment for 75-mm. T50E2 and 90-mm. M71 Complete Rounds."

James A. Ward, plant manager, Remington Rand, Louisiana Ordnance Plant, presented two papers: "Method Used at Louisiana Ordnance Plant for Manufacture of Zone Four 155-mm. High-explosive Shell M107," and "Viscosity Control of TNT for Loading 155-mm. Shell."

H. B. Stevenson, chief technical engineer, Procter & Gamble Defense Corporation, Milan Arsenal, discussed the "Use of High-speed Photography in Analyzing Metal Parts Defects and Malfunctions."

L. R. Rothstein, chief chemist, Mason & Hanger-Silas Mason Company, Iowa Ordnance Plant, presented papers on "Single-Pour Controlled Cooling Process" and "Vacuum Drying of Lead Azide."

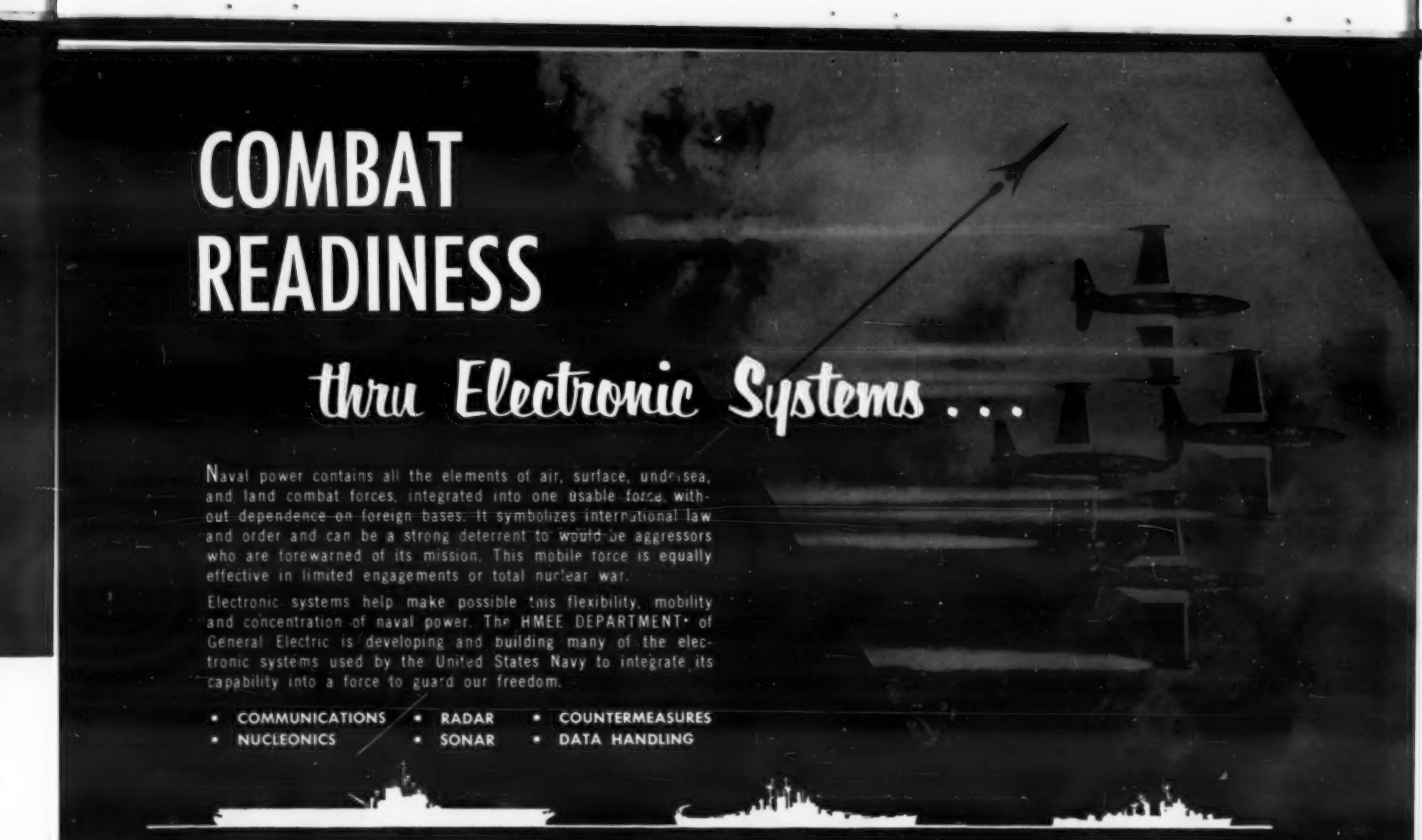
J. A. Batley, safety director, Office, Chief of Ordnance, presented a paper on "Safety and Ammunition Loading."

Mel Johnson, manufacturing division, Ordnance Ammunition Command, presented a paper on "Progress of Ammunition Loading, Assembling, and Packing."

H. S. van Buren, Procter & Gamble Company, cochairman of the Loading

COMBAT READINESS

thru Electronic Systems . . .



Naval power contains all the elements of air, surface, undersea, and land combat forces, integrated into one usable force without dependence on foreign bases. It symbolizes international law and order and can be a strong deterrent to would-be aggressors who are forewarned of its mission. This mobile force is equally effective in limited engagements or total nuclear war.

Electronic systems help make possible this flexibility, mobility and concentration of naval power. The HMEE DEPARTMENT* of General Electric is developing and building many of the electronic systems used by the United States Navy to integrate its capability into a force to guard our freedom.

- COMMUNICATIONS
- RADAR
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A LEADER IN SYSTEMS DEVELOPMENT AND ENGINEERING...

Progress Is Our Most Important Product

GENERAL ELECTRIC

Engineers write for booklet "NEW HORIZONS"

*HEAVY MILITARY ELECTRONIC EQUIPMENT DEPARTMENT • SYRACUSE, N.Y.

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IATRON

Here's the storage tube bright enough for direct viewing in a sun-lit cockpit . . . by several persons in a normally lighted room or a projection display of four feet! With one control knob, operator can set display for any persistence desired . . . from a few thousandths of a second to several minutes. All information can be erased instantly by merely pressing a button!

THE TUBE WITH SUN-LIKE BRILLIANCE

Another Farnsworth achievement . . .

One of many complex electronic products developed, designed, *and produced* for defense and industry . . . backed by over a quarter of a century of continuous success and leadership in the field of electronics.

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A DIVISION OF IT&T

for complete details on the IATRON storage tube, write

FARNSWORTH ELECTRONICS COMPANY • *FORT WAYNE, INDIANA*

a division of International Telephone and Telegraph Corporation

Division Activities

Committee, read a paper on "Continuous Pouring 105-mm. Ammunition at Milan Arsenal."

Keith W. Waugh, National Gypsum Company, Nebraska Ordnance Plant, gave an interesting talk, illustrated with colored 35-mm. slides, about the Nebraska Ordnance Plant.

J. T. Manley, Naval Mine Depot, Yorktown, Va.; Col. Ronald B. Curreus, Ordnance Field Safety Office, Jeffersonville, Ind.; and W. T. August, Navy Bureau of Ordnance, commented on items of interest to the Committee.

An informal get-together and dinner was held at the Hotel Louis Joliet on the evening of February 16th. A tour of the arsenal concluded the meeting.

Military Pyrotechnics Committee Inaugurated by the Bomb and Artillery Ammunition Division

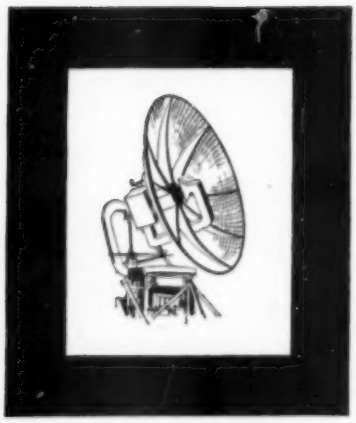
On March 2nd, at the University Club in New York, Robert L. Telford, Mason & Hanger-Silas Mason Company, chairman of the A.O.A. Bomb and Artillery Ammunition Division, launched the newest Committee of the Association. This is the Military Pyrotechnics Committee of the Bomb and Artillery Ammunition Division, which will have as its chairman Dr. Herbert Ellern, director of the Research and Development Laboratory, Armament Division, Universal Match Company, Ferguson, Mo.

Henry N. Marsh, Deputy Assistant Secretary of the Army, (Logistics) and General Chairman of A.O.A. Technical Divisions and Committees (now on leave of absence with the Department of the Army) gave a brief talk on the place of these Committees in the Defense organization.

David Hart, chief of the pyrotechnics section, Picatinny Arsenal, read an excellent paper on "Modern Military Pyrotechnics" in which he sketched their development from the more familiar "fireworks," and the advance of pyrotechnic art from a craft to a science.

Patrick Lizza, president, Bermite Powder Corporation, Saugus, Calif., paid tribute to the A.O.A. and its technical activities and pledged his support.

The Committee was honored to have Vice Adm. George F. Hussey, Jr., president of the American Ordnance Association, as the honor guest at luncheon. After the luncheon Admiral Hussey spoke briefly, crediting the A.O.A. Technical Committees with producing a tangible contribution to our national defense.



NEW FAIRCHILD SHIPBOARD RADAR SYSTEM FOR AUTOMATIC SEARCH AND TRACKING

Fairchild radar systems have gone to sea with missile launching cruisers of the U. S. Navy.

Now operating with the fleet, the Fairchild SPQ-2 Shipboard Radar System shown here was developed to search out and track either missiles or aircraft completely automatically. And, controls have been "human-engineered" to facilitate operation under battle conditions.

Color and shape coding in this new Fairchild radar assure rapid, sure identification of all controls. Rugged, shock-resistant construction protects equipment.

Here again is proof of Fairchild Guided Missiles Division's continuing leadership in design, research and production of vital electronic equipment.

A Division of Fairchild Engine and Airplane Corporation

FAIRCHILD

GUIDED MISSILES DIVISION • WYANDANCH, N. Y.

...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

MORE POWER INTO EACH BITE!

...another reason why Gar Wood 75B's deliver higher production per day!

Output jumps when you put a Gar Wood 75B shovel on the job! One big reason is Gar Wood's positive, independent chain crowd that gets maximum engine power into each load. Since the crowd mechanism is built in, conversion is fast and easy . . . nothing to remove except crowd chain to convert to clamshell, dragline, trench hoe, crane or pile driver. And here are other big 75B advantages:

Extra mobility for speed loading. You can swing, hoist or travel simultaneously.

Fluid coupling that absorbs shocks is available on the 75B. Permits smooth acceleration that increases production, reduces wear and tear on machine.

Power steering for fast, easy operation. Easy to turn and maneuver, regardless of underfoot conditions.

Rugged design reduces maintenance. Massive crawler base takes extreme shock and strain . . . heavy-duty conical hook double rollers eliminate pin strain and rocking under load.

These and many other 75B advantages reflect Gar Wood's long experience in designing and building the finest ¾ yard machines on the market. Get the complete story from your Gar Wood dealer, or write direct to Customer Service Department, Gar Wood Industries, Inc., Wayne, Michigan.

GAR WOOD INDUSTRIES, INC.

Wayne, Michigan • Findlay, Ohio

Gar Wood-Buckeye Ditchers

Gar Wood Tractor Equipment

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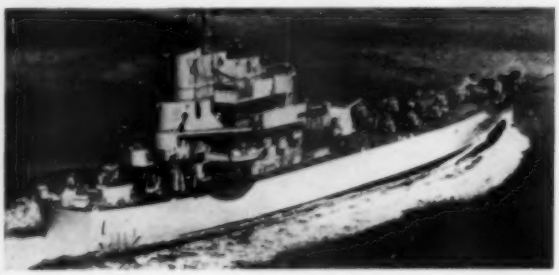
NEW DEVELOPMENTS

BRAIN FOR ROCKETS

A giant electromechanical "brain" has been developed to guide rockets fired from shipboard against enemy ground-troop concentrations ashore. The unique two-computer combination, first to be designed especially for rocket launchers, was built for the



The U.S.S. CARRONADE—New Rocket Ship

Navy Bureau of Ordnance by Ford Instrument Company, Division of Sperry Rand Corporation.

Designated the Mark 91-Mark 92 and installed aboard the U.S.S. CARRONADE, the Navy's first new inshore fire support ship, each computer acts as a unit to perform the required navigational and ballistic calculations involved in the rocket-launching problem.

A key feature of the computer combination is its unprecedented ability to switch instantaneously among several types of rockets, selecting either high- or low-angle fire as required.

The Computer Mark 92 computes and transmits rocket-launcher orders for various tactical situations. It solves the ballistic problems for several types of rockets and four different modes of fire, the selection being made at will by the computer operator.

REDSTONE BATTALION

The Army has announced activation of its first unit to fire the new Redstone ballistic missile. Made up of experienced troops drawn from established Army missile units, the cadre of the 217th Field Artillery Missile Battalion (Redstone) has begun training at Redstone Arsenal, Huntsville, Ala., where it will benefit from the scientific knowledge of the men who developed the missile.

One of the main tasks assigned to the 217th will be to develop field operating techniques. The cadre will gain experience in test-firing the missile both operationally and for development purposes.

NEW RESEARCH WEAPON

A hypervelocity gun that promises to contribute materially to the development of high-speed missiles is the latest research tool of the Aëroballistic Department, U. S. Naval Ordnance Laboratory, White Oak, Md. The new gun makes it possible to bring the missile problem into the laboratory instead of relying entirely on expensive and limited field tests. It is the first such gun ever developed that can launch instrumented models for the study of superhigh-speed aërodynamics.

Already the new gun has fired missiles of golf-ball size at speeds in excess of 10,000 feet a second or almost 7,000 miles an hour. This is the first time that missiles of this size have been

COLD-FORMED by HEINTZ CX*

The Heintz Cold Forming Division is the largest producer, both as prime and sub-contractor, of this 2.75 Mighty Mouse Rocket Head, formed in steel—the combination of extrusion, drawing, coining and nosing operations—all cold.

Heintz Manufacturing Company—the organization that conducted the first Government investigation into cold extrusion of steel—now offers Ordnance and industry the combination of ten years' cold-forming experience... and the largest cold extrusion mechanical press plant in the world.

Here at Heintz, the skilled "CX" organization can supply large or small quantities of cold-formed bodies, cannon shell (large and small), rocket parts, fuse components, pressure cylinders and gear blanks, for similar Ordnance and commercial requirements.

The Heintz Cold Extrusion Process pushes back the horizons of design engineering—saves material . . . reduces machining . . . eliminates assembly. Design for production by the Cold Forming Division of Heintz has been a valuable source of savings and improvements — not only to Navy and Army Ordnance but also to commercial manufacturers.

For unsurpassed research and development facilities . . . for the most modern machines and methods . . . for deliveries on schedule—investigate the Heintz "CX" Process.

A SUGGESTION: Let us consult with you on any design or production problems

Cold Forming Division
HEINTZ MANUFACTURING COMPANY
Philadelphia 20, Pa.

UNDER ONE ROOF—All the integrated services of a key manufacturing facility

CX HEINTZ COLD EXTRUSION

*The new symbol for cost reduction—"CX" = Cold Extrusion by Heintz

fired and photographed at such speeds. Since so little is now known with certainty about the forces that air exerts on objects traveling at these speeds or about the effects such objects have on air, any information obtained will materially increase the rate at which successful high-speed missiles can be developed.

The new hypervelocity gun has a bore of forty millimeters and is approximately sixteen feet in over-all length. Steam-heated helium gas provides the propellant force. The helium is heated by steam resulting from the combustion of hydrogen and oxygen mixed with it.

NEW TRANSISTOR

A new type of transistor, claimed to be ideally suited for guided missiles and for more efficient electronic brains, was recently revealed by the Bell Telephone Laboratories.

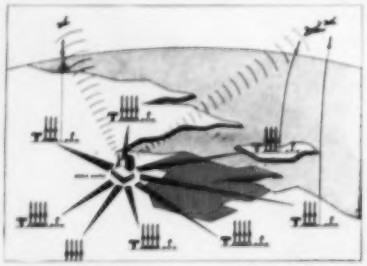
This transistor was made possible by the development of new fabricating techniques described as "a major breakthrough in transistor technology."

The new devices's performance at very high frequencies is said to surpass that of any other transistor now in existence. Because of its very high frequency characteristics, the new transistor opens up many new possibilities for military technology.

The heart of the device is a layer only fifty-millionths of an inch thick.

MISSILE MASTER

The Glenn L. Martin Company recently announced the development of the Missile Master, an electronic system designed specifically for controlling and coördinating the use of Nike antiaircraft missile batteries and other advanced Army weapons as they become available. The system operates independently and can also operate in conjunction with units of the recently announced Air Force semiautomatic ground environment area defense system, known as SAGE.



Typical Missile Master installation.

The Missile Master system collects information on the location of aircraft and their identity, presents this information on electronic displays, and distributes these data to the missile-firing batteries. In this way each Nike battery receives a continuous flow of fresh data on all aircraft within the defense area and on the activities of the other batteries as well, and each Nike battery commander is provided with all the information needed to enable him to make a proper selection of a target.

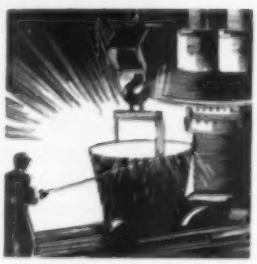
In addition, Missile Master operators observe the activities of all batteries in the system and, where necessary, are able to direct a specific fire unit to a particular target or prevent friendly aircraft from being fired upon by our own weapons.

Each Missile Master system is housed in a large 2-story building. Focal point is the operations center within this building where Army personnel at radar-type display consoles have a view of the over-all air situation in the local area as well as information on activities of the Nike batteries under their jurisdiction. Surveillance and height-finding radar on towers, able to provide independent search and surveillance facilities are installed adjacent to the building.

AIRBORNE RESCUE GEAR

Fifty-six tons of submarine rescue gear are in stand-by status at the U. S. naval

Armament Preparedness is a LIFETIME JOB



ORDNANCEMEN know that preparedness is not just a passing need, but a continuing means of national security. They know that the work of the Association during the past 36 years has been invaluable to our country, and they realize that its job in the days to come will be even more important.

An ever-increasing number of annual members of the Association are transferring to Life Membership. Year in and year out these prominent Americans will be doing their part for the national defense as permanent members of the Industry-Ordnance Team.

AMERICAN ORDNANCE ASSOCIATION
708 Mills Building • Washington 6, D. C.

APPLICATION FOR LIFE MEMBERSHIP

I hereby apply for Life Membership in the American Ordnance Association and request that my membership be transferred from its present annual classification to that of a Life Member. I enclose my check as follows (*please indicate choice*).

☐ $100 (full payment), or ☐ $25 (first of 4 quarterly payments)

☐ Please inform me of my unexpired regular membership dues which may be credited to the Life Membership fee.

Name .....
(*please print*)

Address .....

.....

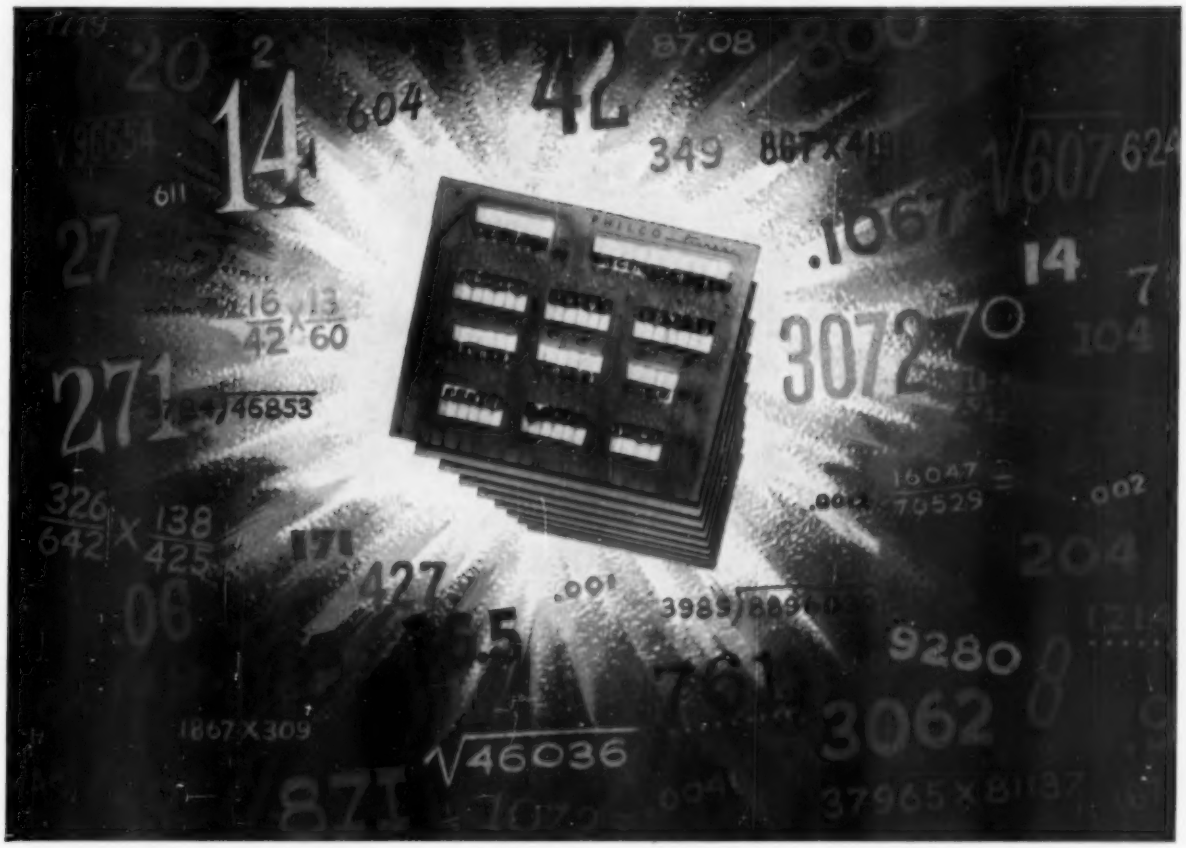
L-105

You are invited to join these leaders in industry and national defense as the "life core" of the Ordnance Association.

As a Life Member you will be certain of continuous membership benefits without bothering to send in annual dues. You will receive the engrossed Life Membership Certificate, and the distinctive Life Membership Lapel Emblem as soon as your membership fee is paid. Each year you will be sent the Life Member Roster, listing your name and the names of all other A.O.A. Life Members.

Make preparedness a lifetime affair by returning the application today!

MATHEMAGICS!

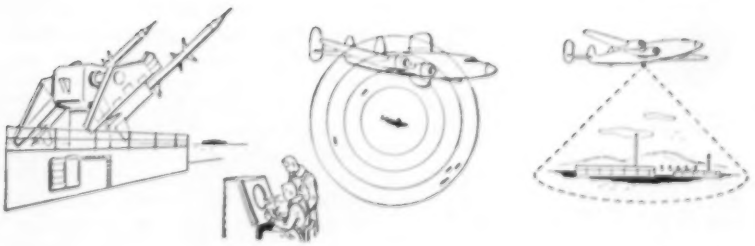


High-Speed Portable Brain Power... transac

Imagine, if you can, a brain that will multiply numbers like 489,737 x 503,692 and come up with the correct answer in 48 millionths of a second. A "Mathemagician" with an electronic memory that staggers the imagination . . . TRANSAC will perform 200,000 times faster than a desk calculator.

Yet, it's the smallest, lightest, most economical electronic computer ever developed. No wonder TRANSAC figures so prominently in the complex computations needed by our Armed Forces. No wonder all industry looks to TRANSAC to speed and advance its vast production schedule.

PHILCO® *...sharing in the vast projects of our Armed Forces to safeguard the American way of life through engineering research and development*



Out of Philco laboratories come far reaching developments in vital military electronic equipment to make a stronger U.S.A. on land, sea and in the air. Philco is proud to be working with the Armed Forces in all parts of the globe with a worldwide service organization of trained specialists.

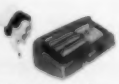
transac — *Trademark of Philco Corporation for Transistor Automatic Computer*

CHAMPION
of SAC competition

The B-47 "City of Merced" . . . a combination of flesh, metal and electronic brains . . . earned the title of "best" in the recent SAC competition. Its K Bombing System, with dependable precision amplifiers, assured exacting "bomb" release for pin-point target hits. Thousands of B-47 "winners" are using DuKane amplifiers in their K Bombing Systems . . . producing an all-weather umbrella of destruction to any would-be aggressor.

DuKane's proven "built-in" reliability gives you this same pin-point precision in specifications, tolerances, production and packaging for your amplifier projects. DuKane will give immediate consideration to any of your amplifier needs. Call or write Government Division, DuKane Corporation, St. Charles 6, Illinois.

AMPLIFIERS UNLIMITED



Nurses' Call

Private Telephone

DuKane's commercial electronic products have established their superiority in schools, hospitals, factories and offices. Details available upon request.

Flexifone Intercom

Central Sound System

Sound Slide film projector

DUKANE CORPORATION
ST. CHARLES 6, ILLINOIS

base at Yokosuka, Japan, for immediate use if needed in a joint Navy-Air Force airborne submarine rescue.

The emergency equipment includes all necessary gear for rescuing men from a stricken submarine, complete to a 7,500-pound diving bell. Everything is trailer-lashed, ready to be placed aboard aircraft at a moment's notice.

The equipment would be landed at the airfield nearest to the stricken submarine. It could then be placed aboard any surface ship in the area which could hoist the huge diving bell.

NEW BOMBING SYSTEM

A new bombing and navigational system of unprecedented reliability developed by International Business Machines Corporation will be installed in the Boeing B-52 Stratofortress—the biggest, fastest bomber employed by the Strategic Air Command.

Periscope of the bombing system.

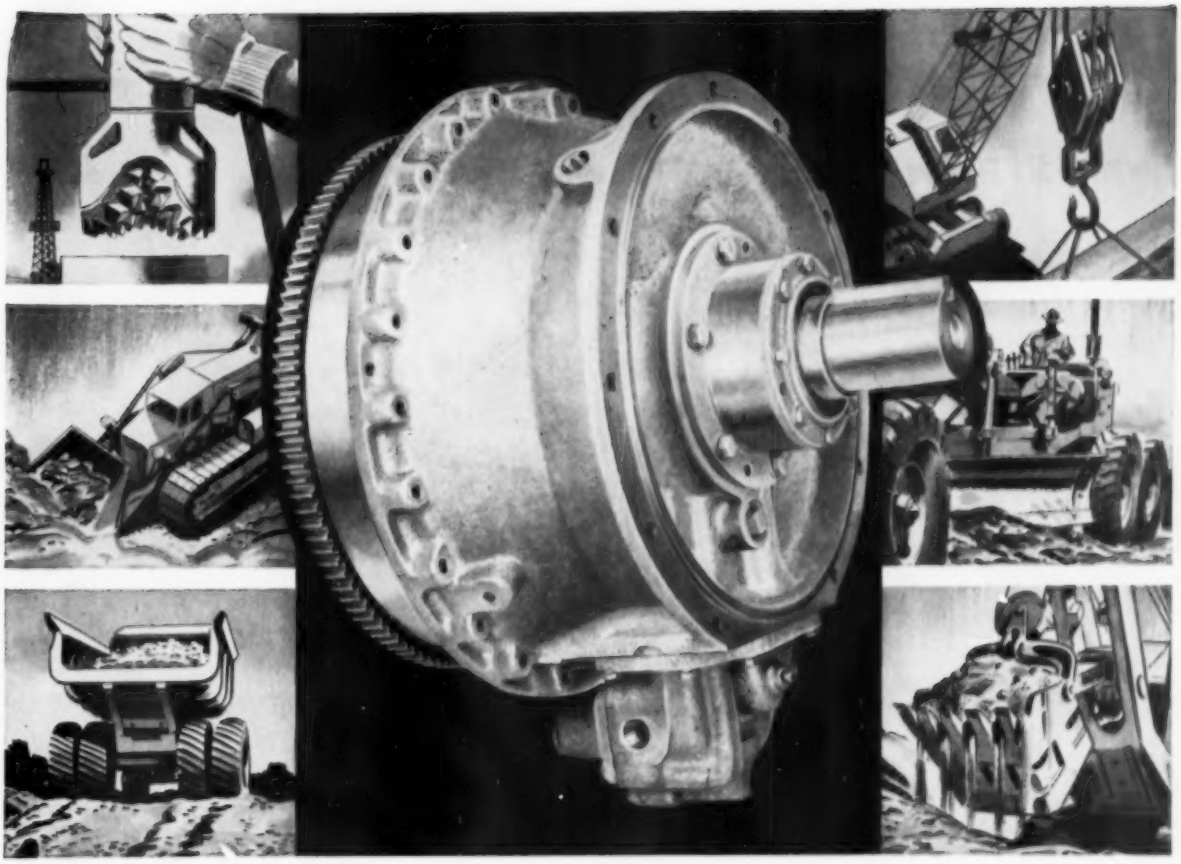
Called the Brane (bombing radar navigation equipment), the new system is built to assist the B-52 crew in carrying out bombing and navigation problems under the most strenuous conditions. The crew employs the navigation equipment to guide the bomber to its destination. Then the system automatically carries the aircraft through the bomb run, responding to corrections made by the bombardier-navigator, who controls the equipment. Exact operational details are restricted by military security, but research is continuing to keep the system abreast of rapid advances in supersonic warplane design.

NEW GUIDED MISSILES

A new guided missile, the Navy-developed "Talos," has been added to the air and sea defenses of the United States and will be installed as antiaircraft defense around Continental Air Force bases and aboard Navy light cruisers. (See photograph on page 972.)

Talos has been described as a longer-ranging, faster, and more effective weapon than the Terrier antiaircraft weapon which the Navy has already installed on its first guided-missile cruiser, the Boston.

The Navy is installing Talos batteries aboard the light cruiser Galveston, now



Versatile is the word for the Torqmatic 500

NAME the gasoline- or Diesel-powered equipment you buy or build in the 100 to 350 horsepower range and it's a sure bet that it's available—or will be soon—with the Series 500 TORQMATIC, *the world's most versatile torque converter.*

Scores of manufacturers—making such varied equipment as cranes, shovels, drilling rigs, log loaders, ditchers, industrial locomotives, scrapers, graders and off-highway trucks—specify the TORQMATIC 500 in the equipment they build, and with good reason.

In one standard housing it gives them a choice of 4 ranges, 7 torque ratios—*and* permits operators to standardize on *one* type of converter for *all* their equipment within the horsepower range.

In many applications it permits the use of lower horsepower engines with no reduction in *working* power because the TORQMATIC 500 multiplies engine torque anywhere from 250% to 360%—*and* means equipment owners will cut operating costs and get more work done per shift.

For full details on the Series 500 TORQMATIC Converter in your equipment write to:

Allison Division of General Motors
Box 894W, Indianapolis 6, Indiana

GM TORQMATIC *Allison* TORQMATIC DRIVES

70% OF THE WORLD IS A POTENTIAL BASE FOR YOUR NEW NAVY

Quick Pick-up!

FOR STRANDED LANDING CRAFT

NEW... from LETOURNEAU

Answering an Army request for a new concept in salvaging capsized or stranded landing craft, R. G. LeTourneau, Inc., Longview, Texas, has designed and built a huge mechanical retriever . . . completely mobile and entirely self-contained. This LeTourneau Landing Craft Retriever is now undergoing tests at Fort Eustis, Virginia. It wades through deep surf or sand to reach distressed craft, picks them up, and returns them to safe water or carries them to repair stations on the beach.

The Landing Craft Retriever is representative of the LeTourneau concept of machine design, in which diesel-generated electric power is directly applied to every working component. For instance, every one of this huge machine's wheels is driven from *within its rim* by a powerful motor and gear reduction contained within the wheel itself. This is the heart of the LeTourneau system of electric power and control — *Electric Wheel Drive*. Combined with huge tubeless tires (4 feet wide and 10 feet high), it provides power and traction for full-load operation across loose beach sand and up grades as steep as 20%. LeTourneau gearmotors also power the Retriever's hoists (which lift up to 70 tons), drive its traveling bridge, and steer the giant wheels.

LeTourneau Landing Craft Retriever rescues immobilized vessels from surf and sand in new salvage method.

Big, powerful, off-road equipment designed around the LeTourneau system of electric power and control is working today — for both military and industry — on jobs heretofore believed "impossible" for mobile machinery.

R. G. LeTourneau, Inc., can put this system to work for you . . . immediately. If your organization needs BIG machines for handling or transporting heavy materials, let us show you how this amazingly flexible concept of machine design can be applied to your specific problems. Send us a resume of your requirements.

Since 1929 — R. G. LeTourneau, Inc., Longview, Texas, has built BIG equipment for 27 years under the same corporate structure. In 1953 LeTourneau sold part of its business, retaining plants in Longview and in Vicksburg, Miss. Today LeTourneau creates and produces electrically powered and controlled equipment for land-clearing, logging, and off-road transportation.

LETOURNEAU

R. G. LeTOURNEAU, INC.

2655 So. MacArthur, Longview, Texas

LET Equipment

G-107

in process of conversion to a guided-missile ship. The new missile attains speeds considerably greater than sound by use of a ramjet engine.

Among the missiles recently discussed by Secretary of the Air Force Donald A. Quarles were the Atlas and the Titan—both in the intercontinental ballistic missile class. Atlas has been under development by the Convair Division of General Dynamics Corporation, and Titan is being developed by the Glenn L. Martin Company using many Atlas components but a different technical approach.

An intermediate range ballistic missile, Thor, was also announced by Secretary Quarles. It is being developed by the Douglas Aircraft Company, Santa Monica, Calif.

SPACE CHAMBER

A futuristic "space chamber" which sets up the same conditions as those awaiting the artificial earth satellite and space ships of the future traveling 80 to 300 miles

Dr. G. K. Wehner inspects space chamber.

above the earth, is now in operation at General Mills, Inc., Minneapolis, Minn. The new device subjects samples of metals and other materials to bombardment by invisible ionized particles moving at speeds of about 20,000 miles an hour.

This research is revealing that even the best of current metals will sputter away or disintegrate under prolonged attack by the atoms and molecules in the region 400,000 feet above the earth and upward, indicating that materials to be sent to the outer atmosphere must have special properties.

The most important discovery to date is that this sputtering tendency is not caused by the heat generated when fast-moving particles collide with a solid substance, but rather it is the momentum (velocity squared times atomic weight) of the charged particles and the angle at which they strike that determines how many atoms will be dislodged.

NEW NAVIGATION AID

A new navigational instrument that presents a pictorial display of the ground and the motion of an aircraft over it is pres-

Long-range striking punch of Regulus guided missiles strengthens your new Navy's powerful underwater fleet

Underwater Aircraft Carrier...

Bold, advanced concepts—atomic power and guided missiles like Vought's pin-point accurate Regulus—help make Your New Navy the most modern force of its kind in the world.

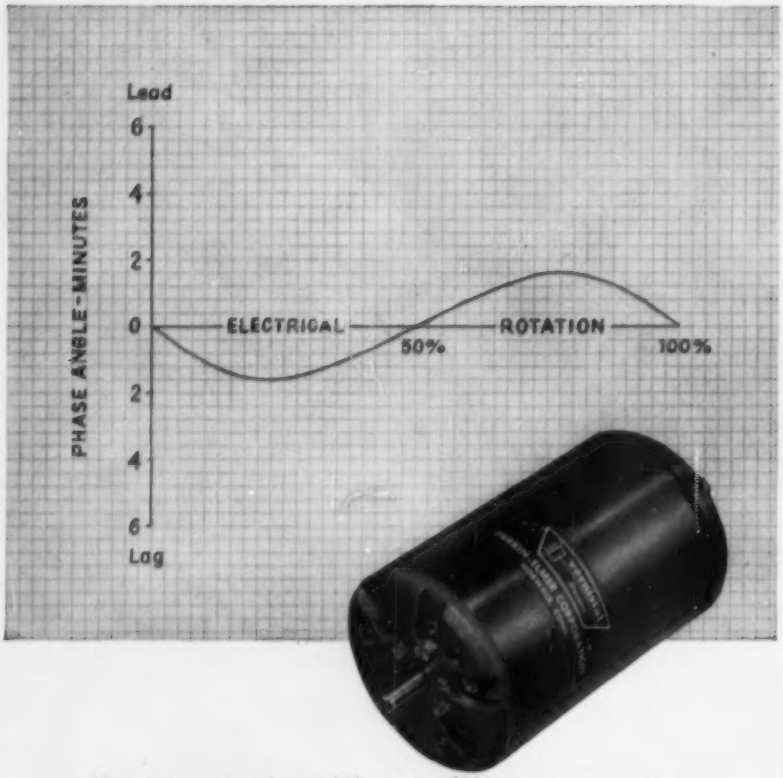
Submarines capable of cruising around the world without surfacing or refueling now can serve also as *aircraft carriers*, with potent, dependable guided missiles giving wings to their deadly striking power.

Regulus thus brings Air Power to the Underwater Fleet—another example of how Vought engineering ability results in weapons that help strengthen the U. S. Navy in its vital mission, control of the seas that cover 70 per cent of the world.

SCIENTISTS AND ENGINEERS: There is a challenging place for you on Vought's creative technical team now. For details write: Engineering Personnel, P. O. Box 5907, Dallas, Texas.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

DESIGNER AND BUILDER OF HIGH PERFORMANCE MILITARY AIRCRAFT SINCE 1917



if you work with position servos...

HERE'S HOW TO LICK QUADRATURE

with the **vernistat*** a.c. potentiometer

If you work with position servos, you have had problems with quadrature. The tighter the servo loop, the more serious unwanted voltage due to phase shift can be.

Quadrature problems are tremendously simplified and more accurate servos are possible when you use the Vernistat. Although it contains a transformer, the Vernistat has extremely low phase shift. Phase angle is less than 1.6 min. at 400 c.p.s. in most systems.

The Vernistat is an a.c. potentiometer that combines *high* linearity and *low* output impedance. Size and mounting dimensions are designed to the BuOrd specification for a size 18 synchro.

SPECIFICATIONS OF MODEL 2B

Linearity Tolerance	± 0.05%
Minimum Output Voltage Increment	0.01%
Electrical Rotation	3494°
Mechanical Overtravel (each end)	45° approximately
Phase Angle (at 400 c.p.s.)	1.6 minutes, maximum
Excitation Frequency	20 to 3000 c.p.s.
Output Impedance	less than 130 ohms
Input Impedance	65,000 ohms, minimum
Maximum Input Voltage	130 V. at 400 c.p.s. or 20 V. at 60 c.p.s.

*TRADEMARK

Visit our booth 507 at the IRE Show

vernistat division

PERKIN-ELMER CORPORATION

Norwalk, Connecticut

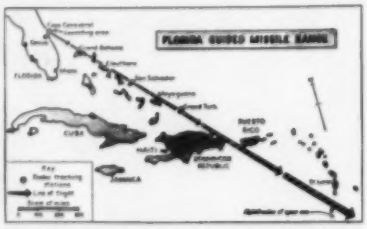
New Developments (Contd.)

ently being evaluated by the Navy's anti-sub squadrons VS-27 and VS-30 based at Norfolk, Va. Padre, short for pilot's automatic dead reckoning equipment, is essentially a pictorial ground position indicator having a transparent plastic grid overlay. Plotting may be done directly on the surface of this grid.

Electrical signals representing true airspeed, true heading, and manual inputs for wind velocity are fed to Padre through an amplifier unit. From this data the computer presents a continuous picture of where the aircraft is with respect to the pilot's plotted data.

RADAR CHAIN

The world's largest chain radar tracking system, capable of checking the flight of the newest supersonic rockets and missiles over the full length of the U. S. Air Force Air Research and Development Command's Florida Guided Missile Range, will be completed this spring.



Stations in the guided-missile range.

Designed and built by Reeves Instrument Corporation, a subsidiary of the Dynamics Corporation of America, at a cost of some $10,000,000, this chain of twenty-one gigantic new radar installations on eight islands extends from Grand Bahama Island off the coast of Cape Canaveral in Florida to the South Atlantic.

The radars can record and report back to the flight control test center in the launching area near Cocoa Beach, Fla., on the missile being tested to an accuracy within two one-hundredths of a degree. They "lock" on the missile the instant it is fired from the launchers and keep it constantly under surveillance.

FUEL INJECTION

The Continental 1790-8 gasoline engine which is to power the Army's new M48 tank will be equipped with a fuel-injection system produced by Simmonds Aerocessories, Inc., Tarrytown, N. Y.

The injection system increases power output, improves cold-starting characteristics, substantially increases fuel economy, reduces backfiring, torching, and hydrostatic locking, requires less maintenance, and eliminates carburetor icing. It automatically compensates for changes in altitude since the metering of the fuel to the combustion chamber is varied with manifold pressure and temperature.

IT'S CRITICAL

IT'S COMPLEX . . . . . IT'S FORGED

This critical jet engine "case ring" with its odd protrusions, thin section and large diameter, would have been a designer's dilemma a short time ago.

Today, Cameron's advanced forging technique, developed on some of the world's largest and most unusual presses for ferrous forgings, has opened new vistas of design, high production and economy.

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P. O. Box 1212, Houston, Texas

THE Y-4 PERISCOPE BOMBSIGHT *used in B-47 Stratojets has 3,433 parts, nearly 2,000 of them in this head-end assembly alone. General Mills manufactures this precision instrument in quantity under a USAF prime contract.*

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THE REASON?

Whittaker Gyros are designed by engineers and built by technicians who have worked together as a team for more than a decade.

Stainless steel construction (even gimbals), meticulous care, continuous testing of components and assemblies, 100% inspection tests of components and assemblies—all add up to gyros that are unsurpassed for dependability.

THE PROOF?

Hundreds of Whittaker gyros are built and shipped each month—with an over-all customer rejection of less than 2%.

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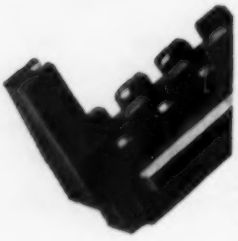

If you have a problem involving the molding of plastic parts, get in touch with the Plastic Machine Specialist at your nearest Fellows office, or write:

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Plastic Machine Division,
Head Office and Export Department, Springfield, Vermont.
Branch Offices: 319 Fisher Building, Detroit 2
5835 West North Avenue, Chicago 39
2206 Empire State Building, New York 1
6214 West Manchester Ave., Los Angeles 45

Fellows

injection molding equipment

MATERIALS PROGRESS

George S. Brady

Nickel: Supply and Demand.—With the possible exception of the hitherto rare metals whose basic production must be increased for new atomic and electronic uses, nickel is perhaps the most discussed metal in Washington today. But there appears to be no generally agreed upon policy. Department of Defense engineers have been scrutinizing all nickel applications with the idea of cutting down the use of this metal which proved to be a bottleneck in the last two emergencies.

Manufacturers of civilian products containing nickel also have been wary of the long-term supply problem. In many cases they have continued the conservation measures inaugurated during the Korean war, and their engineers have been continually scanning applications with the idea of cutting down the content of nickel or finding other satisfactory substitutes.

Suppliers of nickel have naturally viewed this situation with some alarm, with a feeling that some of the old-established markets for nickel will be lost. The Business and Defense Services Administration of the Department of Commerce has echoed this viewpoint and has recently stated that there is likely to be a surplus of nickel and a need for developing new markets after the national stockpile has been filled and new facilities come into production.

In announcing a newly developed piston alloy, D-132, containing only about one-third as much nickel as the former F-132 alloy, the *Aluminum Company of America* states in its advertising brochure that the purpose is to assure a more dependable long-range supply market. This is typical of the attitude assumed by important manufacturers who are fearful that a sudden emergency would bring about a nickel shortage that would make it difficult to continue quantity production of their products.

While nickel has been known and used in alloys for centuries, it is a new industrial metal. In the first years of this century the average world production was only 12,000 tons. Not until the development of stainless steel just before World War I and its use in alloy steels in that war was there any great demand for it.

But it is so indispensable in the type of industrial economy that has developed out of World War II, that the 150,000 tons which will be available to the United States in 1956 would be far short of actual needs if a strict economy in its use in military and civilian products were not practiced.

In 1952, the National Security Resources Board stated in a report that "Demand for nickel has no limits. Consumption is limited by supply." Any use-by-use examination of nickel will show the accuracy of this statement, and it is one which the Government could now safely give out as a policy for at least as long as the Cold War and the defense effort continue.

No other materials in quantity are in sight to replace nickel in alloy steels, strong bronzes, heat-resistant alloys, resistance wire, permeability alloys, low-expansion alloys, nonmagnetic alloys, and corrosion-resistant metals.

Theoretically, nickel is more abundant in nature than copper. There are extensive laterite nickel ores and nickel silicates in many parts of the world, but methods of handling them economically have yet to be developed. Taking into consideration all of the expansion programs contemplated for the next few years, it is safe to say that nothing short of a business depression will ease the pressure on the nickel supply in the near future.

Soil Stabilizer.—Not originally designed for military use, *Armour & Company's* soil stabilizer, Arquad 2HT, is likely to

C-123 TURBOJET COMBINATION PROVES OUTSTANDING

MISSION: Combat Test Problem
WEIGHT: 13,000 lbs. Overload
TAKEOFF CONDITION: Power Failure
RESULTS: Successful

In a recent test for the U. S. Air Force, the Fairchild C-123 proved the value of thrust assist in meeting emergency single engine conditions!

A C-123 was equipped with two Fairchild J-44 jet engines and loaded to achieve gross weight of 66,742 pounds – *13,000 pounds overload.*

During takeoff and climb, both jets were operated to provide 2,000 pounds continuous thrust in addition to the two piston engines. At 2,708 feet, wheels were off the ground, and a moment later at a speed of 122 knots, one propeller was feathered!

From this takeoff position, the C-123 climbed out at 500 feet per minute – proving again its *big job capability and assault versatility,* heightened by jet augmentation to give extra power and extra safety in any emergency.

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Materials Progress (Continued)

find acceptance by the Army as a conditioner and hardener for dirt roads and for stabilizing backfills and embankments. The chemical, dioctadecyl dimethyl ammonium chloride, is derived from plentiful tallow. It is sprayed on the soil and will penetrate to a depth of about six inches, even penetrating large clay clods. It imparts water resistance and hardens the surface, improving traffic conditions on dirt roads comparable to the addition of rock aggregate at a substantial savings in time and cost.

New Pigments.—A new group of pigments, produced by the *Imperial Paper & Color Company*, Glens Falls, N. Y., under the name of Mercadium Reds, and giving a range of shades from light to dark red, are being advocated for use in plastics, paints, printing inks, rubbers, and in some ceramics where the heat encountered is not above 1,000 degrees Fahrenheit, to replace the scarce selenium reds.

The colors are stated to be solid solutions of cadmium-mercury sulphides, made by a carefully controlled process of calcining that prevents chemical breakdown and gives the proper crystal sizes. The colors have good heat and light stability and high tinting strength, and they are lower in cost than selenium or cadmium reds.

But lower cost is not the chief reason for their eager acceptance by some companies. Selenium has been on the scarce strategic list for a long period, and the new colors appear as a satisfactory substitute for those made with this scarce material. But there is some doubt as to the comparative long-range supply value, especially in a time of emergency.

New basic sources of selenium are being developed, and also the use of selenium in rectifiers is likely to decrease as the silicon rectifier comes into greater commercial production, whereas mercury, which is largely an imported material, is being called for in quantity for many new applications. In the next emergency, mercury is likely to be in scarcer supply than selenium.

Isosebacic Acid.—With the completion next year of a plant at Tuscola, Ill. (*U. S. Industrial Chemicals Company*), to produce 10 million pounds annually of isosebacic acid, the stockpiling of castor oil may be obsoleted. This oil has been used to produce sebacic acid for the making of a type of nylon valued for insulation.

Isosebacic acid is made from petrochemicals and sodium. It contains eighteen per cent sebacic acid, with the balance suberic acid and diethyl adipic acid, and it will produce polyamide resins with the desired electrical characteristics.

Aluminum Rotors.—Six aluminum rotor blades are used on the Turbo Transporter of the *Vertol Aircraft Corporation*. The blades are 34 feet long, and are made from 1 1/5-inch plate formed by the *Chicago Bridge & Iron Company* into half sections thick at the hub end and gradually tapering to the tip. The formed halves are fitted together and are strengthened internally with a honeycomb of aluminum foil to prevent droop.

Foil for Packaging.—The largest single peacetime use of aluminum is now for foil, the present demand for aluminum foil exceeding 100,000 tons annually, which represented nearly 7 per cent of the primary aluminum production in 1955. It is used mainly for packaging, and it is not a use that can be cut down easily in a war emergency. More than 20,000 tons of thin sheet and foil are used annually by food-processing plants for frozen foods, bakery products, and ready-to-cook foods, and this quantity is expected to double by 1960.

Because these items reduce greatly the work in homes and in military kitchens, this metal consumption will have to be

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1st choice of the industry!

Perhaps no other group of businessmen is as cost conscious as the men who make up the great trucking industry. For the difference between profit and loss in the truck field is mostly a matter of operating costs.

Therefore, when the truck industry gives overwhelming preference to any one product, you can just bet your bottom dollar the product of their choice is the outstanding value in its field.

That's why every segment of the industry—truck manufacturers, operators, and dealers—agree you can't beat Bendix* Power Brakes for efficiency, long life, and economical operation.

In a way it is only natural that Bendix should receive this industry-wide endorsement, for Bendix has an unrivaled wealth of diversified experience in successfully meeting the braking problems of the industry over the years.

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Bendix Products Division

Bendix AVIATION CORPORATION

A small pebble in a big pond. . . .

Drop a small pebble in a big pond and the ripples created by the impact will travel in ever widening circles over the entire surface.

Ordnance is a vast pond and Vulcan is proud that its first impact as a small pebble soon reached the farthest bank.

This is borne out by Vulcan's steady growth and development since entering the field of Ordnance as Contract Machine Specialists and builders of fine Custom Precision Gages.

VULCAN'S superior craftsmen and equipment offer you . . . . ENGINEERING — An expertly staffed department to plan and design. . . . . TOOLING — Skilled craftsmen to build efficiently, accurately and economically. . . . PRODUCTION — Years of experience, covering a highly diversified industrial and ordnance field.

Vulcan is big enough to serve you — yet small enough to give each contract, prompt personal attention.

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WAYNESBORO • PENNSYLVANIA

Contract Machine Specialists

ENGINEERING • TOOLING • PRODUCTION

Materials Progress (Contd.)

considered in a war emergency as "essential civilian." *Aluminum Company of America* is installing three additional 72-inch foil mills at its Tennessee works which, with the new mills at Davenport, Iowa, will more than double its capacity for aluminum foil by the end of the year.

Aluminum Versus Steel.—The advantages of aluminum over steel for some heavy construction work, such as long-span bridges, has been featured by *Kaiser Aluminum & Chemical Sales,* Oakland, Calif. Aluminum alloys 2014-T6 and 6061-T6 will carry the same load as an identical steel structural member and will weigh only one-third as much as the steel member.

Even applying a greater safety factor than is usual for steel, the aluminum members will save at least 50 per cent in weight, thus reducing fabricating, erecting, and transportation costs. Substantial savings are made in maintenance costs because of superior corrosion resistance and the elimination or reduction of painting.

In regard to stiffness, a 7-inch aluminum I beam, weighing 5.42 pounds per foot, has 3 times the moment of inertia of a 5-inch steel I beam weighing 10 pounds per foot. Thus, with only half the weight of steel, the aluminum beam stresses due to bending will be less than half those in the steel member.

The low elastic modulus of aluminum reduces stresses caused by inexact fitting of members, and also lessens the stresses caused by temperature changes in riveted members, more than compensating for the greater thermal expansion of aluminum. Improved inert-gas arc welding, giving joint efficiencies from 80 to 100 per cent, also has favored increased use of aluminum for heavy construction.

Plastic Sailboat.—A new 42-foot sailboat built by *Luria-Cournand, Inc.,* is made entirely of plastic. The hull weighs five tons. Built over a removable wooden form, the hull is made of layers of glass cloth impregnated with *American Cyanamid Company's* Laminac polyester resin (40 per cent glass cloth and 60 per cent resin and pigment). No painting is ever needed, and the surface is easy to keep clean.

Improved Battery.—An increase in plate size without increase in the size of the battery is obtained in the new Exide industrial storage batteries of the *Electric Storage Battery Company,* Philadelphia, Pa., by the use of strong and tough polyethylene plastic throughout, including tubing and tube sealers. The polyethylene-encased batteries have high capacity and longer battery life.

Pipe Armor.—At Corning, N. Y., the *Corning Glass Works* is now producing

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One of the most valuable features of aluminum is its versatility. It is strong, light, decorative, permanent, and easy to work. The versatility of aluminum is more than matched by the many ways Harvey puts it to work for you. Whether your needs are for large structural elements, or small parts Harvey can supply them for you. If you need giant-sized forgings or extruded shapes for increasing strength, improving construction, or reducing weight, we'll supply them; or if you need smaller components in the form of extrusions, forgings, impact extrusions or machined parts to improve your product or reduce your fabricating costs, Harvey can help. You'll find it pays, when specifying aluminum, to *specify Harvey.*

Harvey is a leading independent producer of quality aluminum products. Extrusions in all alloys and in all sizes, special shapes, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tube, impact extrusions, aluminum screw machine products and related products. Harvey is also producing similar items in titanium and steel.

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No. One
By Joseph Pennell

"The Gun Pit" is one of four attractive Pennell reproductions available to Ordnance Association members who recommend friends for membership in the A.O.A. You can receive Series I of A.O.A. Prints (the Pennell lithographs) as soon as four of your recommended friends become new A.O.A. members.

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Materials Progress (Contd.)

an armor sleeve to encase its Pyrex glass pipe to give greater strength and hold the glass together in case of failure or accidental breakage of the pipe. The armor consists of a tight-fitting sleeve, 1/16-inch thick, made of glass fiber impregnated with a polyester resin. After assembling and curing, the sleeve adheres tightly to the pipe and will not shatter. The glass piping is used in chemical plant lines to replace the scarce and more expensive piping of corrosion-resistant alloys.

Ductile Armed.—A process for making ductile austenitic iron by treating with magnesium in a somewhat similar manner as in making ductile cast iron has been developed by the *International Nickel Company*, New York, N. Y. The new iron has graphite in spheroidal form instead of the flake graphite of regular austenitic iron, but with the added ductility it still retains the corrosion resistance and wear resistance of austenitic iron. The tensile strength also is increased.

An iron with 26 per cent chromium, 20 nickel, and 1 maganese has a tensile strength up to 69,000 pounds per square inch, elongation 8 to 20 per cent, and Brinell hardness of 140 to 180. At a temperature of 1,400 degrees Fahrenheit it has a tensile strength of 22,000 pounds per square inch. It casts well, and is recommended for engine, pump, and furnace castings.

Leather Coating.—A water repellent has been developed by *Eastman Kodak Company*, Rochester, N. Y., for coating leather and textiles that permits water vapor, but not water, to pass through, thus permitting "breathing" through the leather. The material is an acrylic ester polymerized with a vinyl. In connection with this, it is interesting to note that at the beginning of World War II more than 70 per cent of all shoe soles were made of leather, while now only about 35 per cent are of leather. Leather has been the time-honored material for shoes, but it soaked up water easily and was not durable. However, to replace it effectively required a water-repellent coating that would permit breathing through the material.

New Lubricants.—Since World War II there has been much improvement in lubricants, both in synthetic chemical lubricants and in chemical additives to improve the petroleum lubricants. *Hooker Electrochemical Company*, Niagara Falls, N. Y., is now recommending its Fluorolube oils and greases as lubricants for bearings, valves, and pumps where there is exposure to severe oxidation or to strong acids and chemicals.

The materials are polymers of trifluoro

reliability

no new subject at Collins

Although the subject of reliability is currently attracting great interest among communication people, it has always been a basic design consideration at Collins. The maturity of Collins reliability program is exemplified in Collins leadership in supplying military and commercial aeronautical customers with both ground and airborne electronic equipment. Maximum reliability is designed into all equipment in engineering and is assured through manufacture by constant inspection and test. Guaranteeing this reliability is a well-organized four point reliability program:

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Maximum simplicity possible in original equipment design.

Component Evaluation
Extensive testing to assist design engineers and to maintain control of component use. Cooperation with suppliers to improve component reliability.

Equipment Testing
Continual checking during manufacture plus endurance and environment final tests to assure reliability specifications.

Systemetized Reporting
Field service personnel channel performance data through engineering and manufacturing for reliability improvement.

BOTTOM LEFT
Frequency recording equipment plots oscillator stability to assure optimum performance of ground receivers to be delivered to the military.

BOTTOM RIGHT
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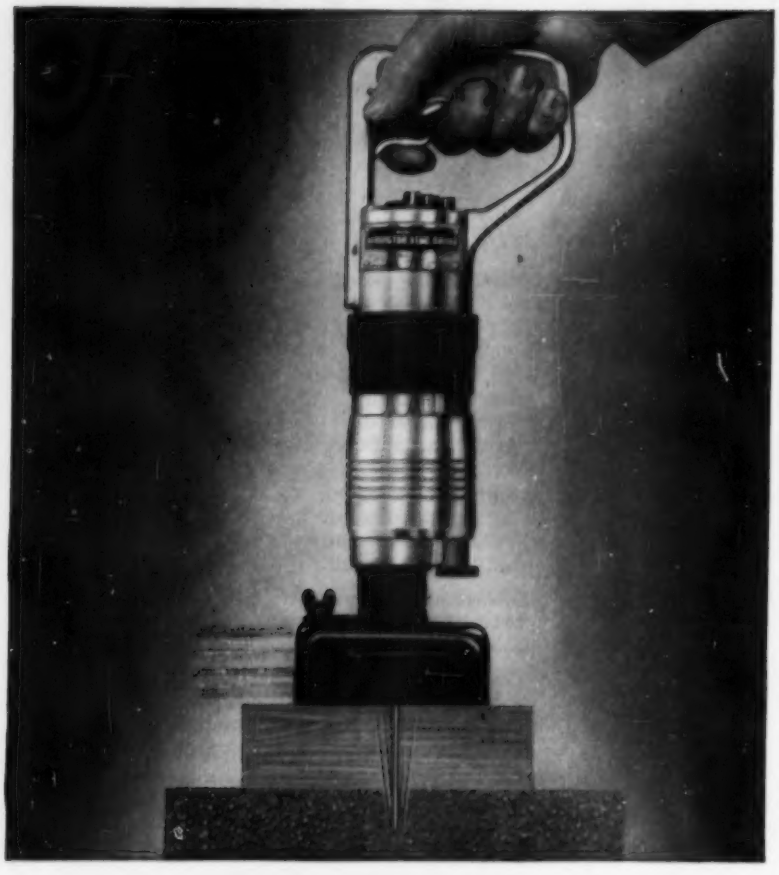

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Materials Progress (Contd.)

vinyl chloride, varying in density from 1.88 for the light oils to 2.0 for the greases. They are not broken down by concentrated nitric acid or oxygen or by heats to 300 degrees Centigrade, and they are nonflammable.

Colored Aluminum.—Aluminum sheet, rod, and extruded shapes in various colors that will withstand severe outside weathering is now being offered by the *Aluminum Company of America*, Pittsburgh, Pa. A hard oxide is built up on the metal, colored with dyes, and sealed in so that the color is an integral part of the metal. Colors available at present are black, brown, blue, gray, green, yellow, and gold.

Aluminum castings also are being offered in colors by the *Monarch Aluminum Manufacturing Company*, Cleveland, Ohio. The castings are finished with a colored vitreous enamel that is more ductile than ordinary procelain enamel. The castings can be machined without chipping the edges of the remaining enamel, and welding can be done without discoloring the surface.

New Solvent.—The *E. I. du Pont de Nemours & Company*, Wilmington, Del., now has a solvent for synthetic resins for lacquer and other uses that is claimed to give more concentrated solutions at any given viscosity and to show less change in viscosity with change in solids content. The material, called Hytrol O, is a cyclohexanone, $C_6H_{10}O$, a liquid of specific gravity 0.9478, with flash point at 129 degrees Fahrenheit and boiling at 314.1 degrees. It is not corrosive to metals.

Foreign Technical Data.—The best articles from European technical and industrial journals, translated and digested, are now available monthly to American industry. The Organization for European Economic Coöperation, a multigovernment agency set up to stimulate economic growth of member nations, will distribute its monthly publication, *Technical Digests*, in the United States.

It is designed primarily for those interested in manufacturing and production, and many of the articles in the periodical, which averages 140 illustrated pages, discuss new products and processes developed by European manufacturers.

The Department of Commerce through its Office of Technical Services is coöperating with O.E.E.C. in making this new source of information known to American industry.

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The taxpaying public usually pictures Uncle Sam as being a loose man with a dollar, busily throwing our cash away with both hands. American industry, serving the defense program, will tell you nothing can be farther from the truth. On the contrary, the Government is running for top honors for sharp-pencil buying.

Typical of the Government's conservation program is the wide acceptance of rolled and flash welded rings as the most economical way to produce circular weldments for jet aircraft engines, guided missile parts and many other products of our military defense program.

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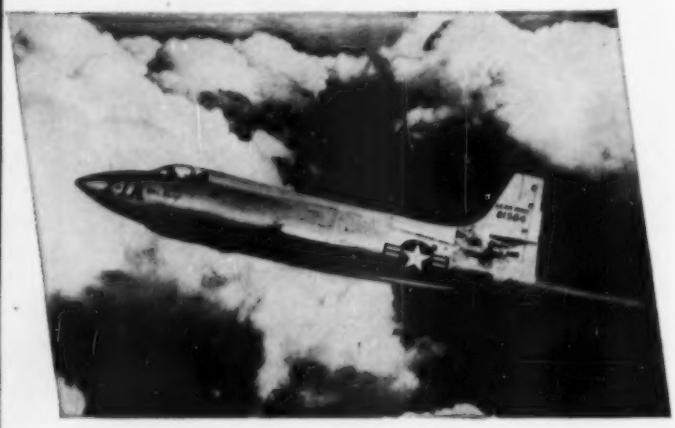
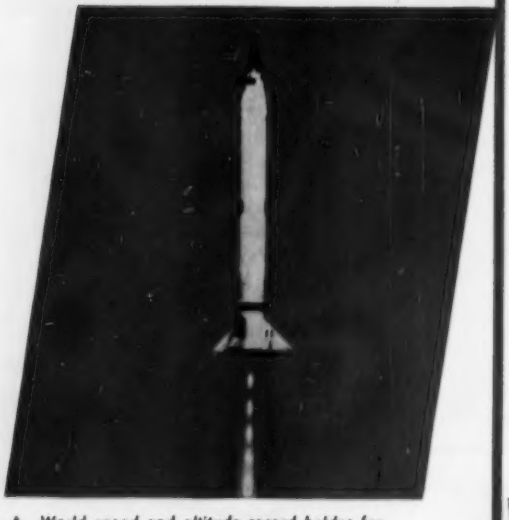


★ *World speed and altitude record holder for piloted aircraft . . . RMI rocket powered Bell XI-A.*



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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—The 3-stage rocket which will establish the U. S. earth satellite will use an improved *Viking* rocket as the first stage, a modified *Aerobee* rocket as the second stage, and a solid-propellant rocket as the third stage. The rockets will be stacked atop one another and will have decreasing forward diameter.

The length may be about seventy feet with a maximum diameter of about three or four feet. The total launching weight may be some five to ten tons. As it now stands, ten or possibly twelve satellites will be launched. Launching will take place at the Air Force long-range test center in Florida. The range is now being extended to St. Lucia Island, giving an instrumented course of 1,600 miles.

In addition, the governments of the United States and Britain are now negotiating for the use of St. Helena Island off the African coast some 5,500 miles away from Florida. The St. Helena location (and possibly stations near Natal, South America) could also be used for tests on the *Atlas* intercontinental ballistic missile.

The earth satellite vehicle will be launched eastward at an angle of about forty degrees from the equator. In addition to gaining some velocity from the rotation of the earth, this trajectory would allow the satellite to circle over major earth areas.

Estimated probability of attaining a satellite is placed at around fifty per cent, and lifetime of the satellite may range from two weeks to two months. The exact configuration of the actual satellite has not yet been announced. In any event, it will be small (20 to 30 pounds), but it will be our first attempt. Larger ones may be expected to follow.

Missiles.—The big news in missiles has been concerned with our long-range program. Our longest-range ballistic missile is now the Army Ordnance *Redstone* with a range now reported to be around 200 to 300 miles. The Chrysler Corporation will develop an intermediate-range ballistic missile for the Army and Navy with a range of about 1,500 miles. Another intermediate-range ballistic missile is to be developed by Douglas Aircraft for the Air Force.

Our intercontinental-missile program is to be intensified by accelerated development of the 5,000-mile-range *Atlas*. Another ICBM is to be developed by the Glenn L. Martin Company and now carries the designation, WS-107. Two other long-range missiles, the ramjet-rocket *Navaho* and the turbojet *Snark*, are both of the cruise variety in various stages of development for the Air Force (see photograph on page 957).

The Navy is increasing its developments in the missile field. The *Tartar* missile is to be developed as a 5-inch naval gun battery replacement. *Talos* is a surface-to-air Navy rocket-ramjet missile that is also being developed for the Air Force and the Army. Accelerated by a solid-propellant booster rocket, the ramjet can hit a speed of Mach 2. It bears a strong resemblance to the Navy *Terrier* missile (see photograph on page 972).

Recently the Navy conducted Arctic test firings of a 2-stage rocket consisting of the *Deacon* and *Loki* solid-propellant rockets. *Sidewinder* is an air-to-air missile which will be produced for the Navy by Philco and General Electric.

The Navy has developed a new launching technique for its *Regulus* missile. The missile is mounted on a launching cradle

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which is hooked onto the steam catapult system of an aircraft carrier. This process eliminates the need for costly launching rockets and speeds up the launching. The *Petrel*, AUM-N-2, an air-to-underwater missile, is now approaching the operational stage.

Meanwhile, a second submarine, the U.S.S. BARBERO (SSG-317) has been converted to guided-missile use. The SSG-317 will join her sister missile sub, the U.S.S. TUNNY, in the Atlantic fleet. The *Regulus* missile can be launched by both submarines.

The Army, too, is gaining in missile stature. Six *Corporal* battalions will join other units already in Europe. Each Corporal battalion has two batteries of five launchers each and is composed of 250 men. The Corporal missile is all-weather and can deliver conventional or atomic warheads to ranges of fifty to seventy-five miles. The missile weighs about 5 tons, is 46 feet long, and has a diameter of 2.5 feet.

Meanwhile, the Army has shed some light on the capabilities of its *Honest John* rocket. At a recent firing in Japan, the missile came within 43 yards of the bull's-eye at a range of 10,900 yards. On this trip, the 6,000-pound, 27-foot-long missile carried a concrete warhead. Honest John also can carry conventional explosives or nuclear warheads.

The Air Force has released some specifications concerning its Martin *Matador*, TM-61, missile. The Matador is launched by a solid-propellant booster rocket, the T-50. Sustaining thrust for cruise comes from an Allison J-33-A-37 turbojet engine delivering 4,600 pounds of thrust.

The missile has a length of about 40 feet, a wing span of about 29 feet, and has a launching weight of about 12,000 pounds. The TM-61 costs about $90,000 each, can fly at a speed of about 650 miles an hour at an altitude of over 35,000 feet, and has a range of about 600 miles. Development was started in 1946, and the missile first came off the assembly line in 1952 (see photograph on page 957).

Another Air Force missile, the *Falcon* guided aircraft rocket, GAR-1, is rolling off the Hughes Tucson, Ariz., facility in larger numbers. Designed for use with the F-102, the missile is also to arm new models of the F-89H interceptor.

The interceptor will carry three Falcon rockets in each wingtip pod. The 2.75-inch *Mighty Mouse* rockets will also be carried. Present Falcon cost is about $25,000 to $50,000 with the possibility that it may soon carry a nuclear warhead.

Another Air Force rocket under development is the *Rascal*. An air-to-surface weapon, Rascal, may be used in conjunction with the B-52 or the B-58 supersonic bomber under development. The unmanned missile is launched some fifty to one hundred miles from the target area and is guided to the target by the mother plane. This technique will make bombers less vulnerable to both enemy defenses and the blasts of nuclear weapons.

Research.—Several new test tunnels and ranges are indicative of new weapons in the works. The reëntry of intercontinental missiles into the atmosphere will be studied in a new half-million-dollar "atmosphere-entry simulator" at the Ames Laboratory, Moffett Field, Calif. (NACA). Another new NACA tunnel is to be erected at Langley Field, Va. The Langley tunnel will cost $6.5 million and will have a speed capability of Mach 10.

General Electric is to build a new wind tunnel which will operate at Mach 50 to 100. No other details have been released.

A new ballistic range—for firing live guns and rockets is being built by the Cornell Aëronautical Laboratory at Buffalo, N. Y.

Rocket sled tests are expected to give more information about man's chances of survival after bail-out from high-speed aircraft (see article on page 975).

Cold drawn Shelby Seamless Tubes provide *high strength, low weight* outrigger struts for B-47 Stratojet

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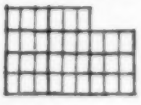
STACK BETTER  **STORE BETTER**

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ARMAMENT ELECTRONICS

Dr. W. S. Carlson

IMPROVEMENTS and innovations in metallurgy underlie many of the important advances made in electronics during the past decade. Zone-melt refining of germanium and the precisely controlled techniques of alloying employed in the production of transistors come readily to mind. Significant progress also has been made in the fields of powder metallurgy and ceramics. Finely divided iron was used experimentally over fifty years ago as a magnetic core material.

Only within the past twenty-five years, however, have sources of powdered metal and binders suitable for mass production of cores been developed. Familiar applications of powdered iron cores include permeability tuned i-f transformers for radio and television receivers. Molybdenum permalloy powder cores, which exhibit a relatively linear magnetization characteristic and a low loss factor, are used in communications.

More recently, ferromagnetic ceramics have become available. These materials, commonly known as ferrites, are obtained by sintering mixtures of powdered iron oxide and other divalent metal oxides such as MnO and ZnO. Ferrites, being nonmetallic, can be prepared to have extremely high volume resistivity. Ferrite cores can therefore be operated in magnetic amplifiers at high excitation frequencies without eddy current losses. In consequence of eddy currents, initial (A.C.) permeability of conductive ferromagnetic materials varies inversely with frequency.

Adopting as an amplifier sensitivity criterion that the initial permeability shall not be less than half the maximum (D.C.) value, a practical limit for the best nickel-iron alloys in 0.001-inch tape thickness would be on the order of 100 kc. Using the same criterion, the frequency limit for a typical ferrite would be >1,000kc. It should not, however, be concluded that ferrites will completely displace ferromagnetic alloys either in magnetic amplifier or computer applications. Permalloy tape can be rolled to <0.0002-inch with reasonable control of magnetic properties, making it possible to obtain amplifier time constants on the order of 1μ second.

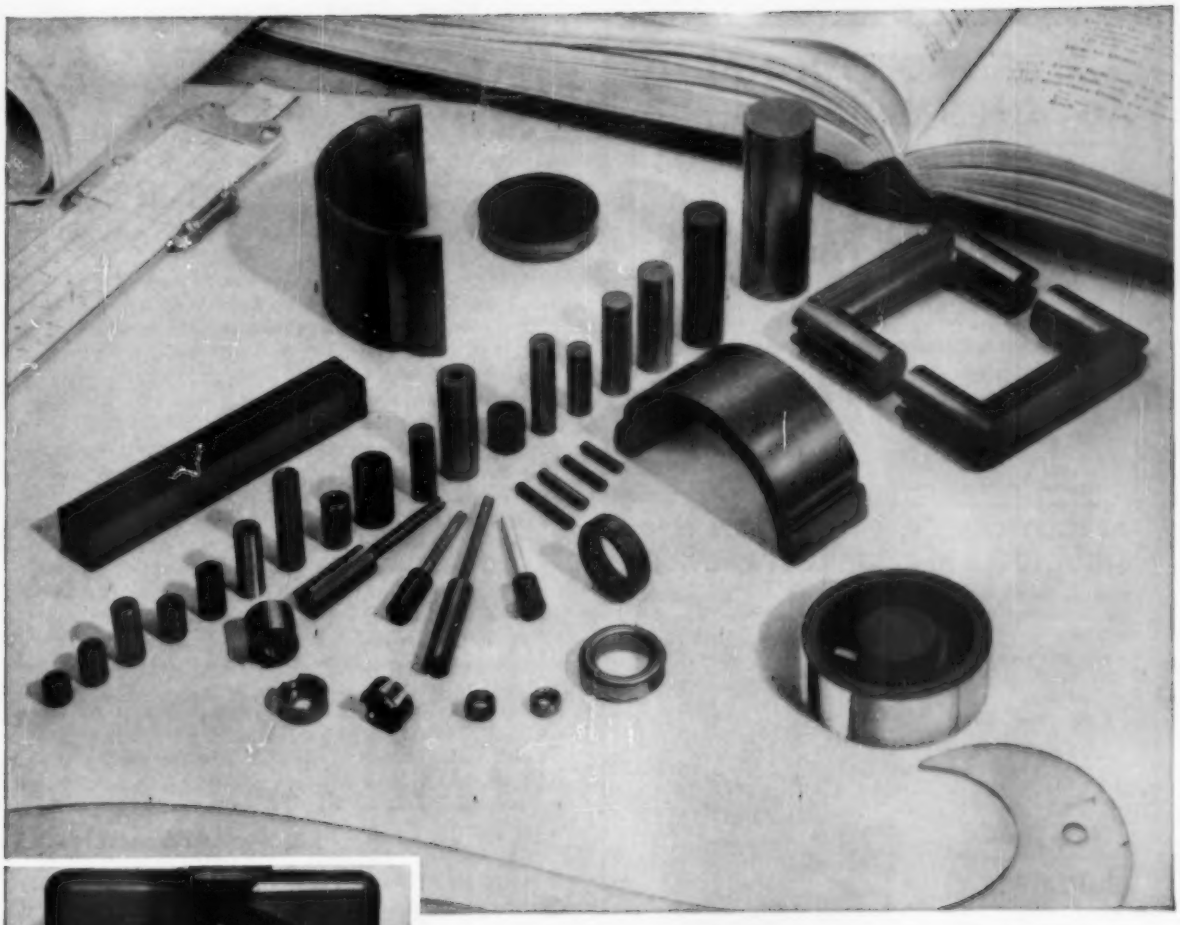
On the other hand, the superior efficiency of ferrites at high frequencies is largely offset by lower initial permeability. A magnetic core memory element for computer applications should exhibit an essentially rectangular hysteresis loop. This implies a residual magnetization (Br) almost equal to the maximum magnetization (Bm) induced by the switching pulse.

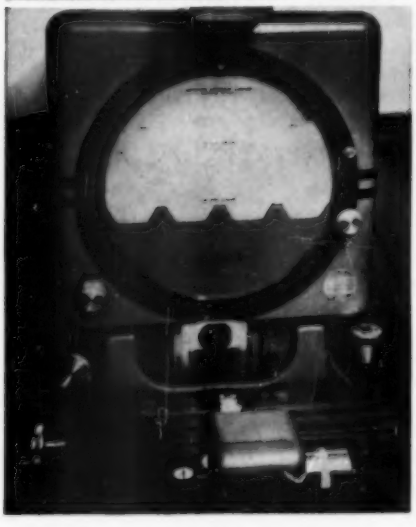
Cores intended for use in an arbitrary access memory matrix should yield a squareness ratio Br/Bm close to unity. The more nearly this requirement is met, the larger will be the ratio of flux changes induced by the read-out pulse as between "stored zero" and "stored one" in the core.

Rectangularity of permalloy cores may approach .98 for the lowest magnetizing force capable of producing saturation. Presently available ferrites are not significantly inferior with respect to Br/Bm ratio but require somewhat higher pulse currents.

FERRITES also have found application as cores for loop antennas. The voltage developed at a given field strength around a loop oriented for maximum pickup depends on the rate of change of flux linkages through the loop. By introduction of a high permeability body the flux linkage is obviously increased.

The basic concept of using a magnetic core to increase the effective area of loop antennas built into broadcast-band receivers





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is by no means new. However, until ferrites became available, reduction to practice was not economically feasible.

A number of microwave applications for ferrites have developed around the Faraday effect—a rotation of the plane of polarization caused by a magnetic field parallel to the direction of propagation. The rotation is usually proportional to the field strength and length of the optical path through the transmitting medium.

The constant of proportionality per unit thickness of the optical medium and field strength is known as the Verdet constant. Unlike the rotation produced by optically active media, such as quartz, the direction of Faraday rotation depends on the sense of the magnetic field with respect to the direction of propagation.

In ferromagnetic media the rotation produced depends on the magnetization rather than on the impressed field. Relatively large rotations can be produced in media of high permeability.

A recently reported test of a microwave modulator will illustrate the principle. A ferrite slug mounted coaxially in a section of circular waveguide was interposed between two sections of rectangular guide. The planes of polarization in the rectangular guides were made mutually perpendicular. By means of a solenoidal winding around the circular section the ferrite could be magnetized sufficiently to produce a 90-degree rotation of the plane of polarization. In this way the ferrite can be made to function as a switch or modulator by controlling the magnetizing current.

It was found that output of the system could be varied more than 30 db. No duplexer or absorber was used to prevent reflection back to the source. In more sophisticated versions of the device, provision is made to absorb reflected energy which might otherwise damage the microwave generator.

LOAD isolators using ferrite cores polarized by means of a permanent magnet are commercially available. The one-way transmission afforded by these devices can be used to reduce frequency pulling and moding encountered when a magnetron is coupled to a varying load through a long transmission line. Depending on frequency and power to be handled, 10 to 18 db of isolation can be obtained for an insertion loss of 0.5-1.5 db. When the device is properly terminated, forward vswr is about 1.05-1.20.

Considering the ratio of isolation to insertion loss as a figure of merit, the ferrite isolator is obviously superior to conventional attenuators. A number of devices exploiting the nonreciprocal properties of ferrites in a magnetic field have been described. These are variously called isolators, gyrators, and circulators. All are based on the fact that propagation through a ferromagnetic medium rotates the polarization of an electromagnetic wave in a direction which depends on the sense of the magnetic field.

It is therefore possible to contrive a transmission line which, in effect, differs by a half wavelength in electrical length as between positive and negative directions of propagation. The usual explanation of the phenomenon is based on resolution of the plane polarized wave into two circularly polarized components which propagate at unequal velocities in the ferrite.

Ceramic dielectrics exhibiting useful properties also have been developed in recent years. Polycrystalline barium titanates have found application as electromechanical transducers. Although affording a smaller conversion index than Rochelle salt, the ceramic transducer is easier to fabricate and can be used under conditions of temperature and humidity which would adversely affect Rochelle salt.

A number of accelerometers have been designed around barium titanate ceramic as the piezoelectric element. Sensitivity of 45 millivolts per g has been obtained with devices having a natural period >6,000 cps.

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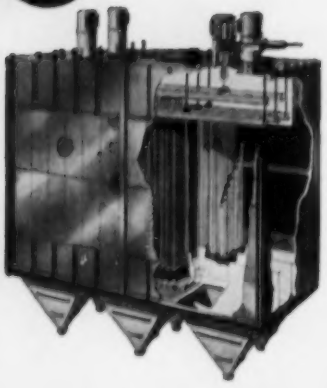

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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*—THE EDITORS.

Jet Flame Holder.—*U. S. Patent No. 2,726,511. Issued December 13, 1955, to Paul A. Pitt. Assigned to Solar Aircraft Company:* As the altitude increases, the flame front in a jet engine moves further downstream. At very high altitudes, combustion occurs outside the jet engine nozzle, thus contributing nothing to driving the aircraft forward and causing blowout. In this invention, these difficulties are avoided by employing a secondary flame-anchoring gutter or flame holder downstream of the primary gutters. This stabilizes the main combustion, providing materially improved performance at high altitudes without impairing performance at low altitudes.

Underwater Blasting Detonator.—*U. S. Patent No. 2,726,602. Issued December 13, 1955, to Clyde O. Davis, Harold A. Lewis, and George A. Noddin. Assigned to E. I. du Pont de Nemours & Company:* Relatively insensitive blasting explosives may be used for underwater blasting by means of the detonator described. The detonators are pressure-sensitive; *i.e.*, they collapse under pressure. An ignition charge contained in the detonator becomes ignited as a result of the impact of the collapsing walls. A high-velocity, high-density detonating explosive base charge within the cap is brought to explosion by the ignition charge by way of a compressed intermediate charge. Thus, when one explosive charge placed near other explosive charges is detonated by an electric blasting cap, the other pressure-sensitive detonators collapse and also detonate.

Pyrotechnic Composition.—*U. S. Patents Nos. 2,726,943 and 2,726,944. Issued December 13, 1955, to Raymond H. Heiskell:* These patents relate to dark-burning nonflash igniter compositions adapted to ignite the tracer compos.tion in a projectile. The object is to avoid revealing the location of the gun firing the projectiles as well as to avoid confusion when aiming a gun by observatio[illegible] the tracer streak. The compositions disclosed which have this effect are as follows: No. 2,726,943—up to 10 per cent lubricant, 10-75 per cent manganese, the remainder being cupric oxide, barium peroxide, antimony pentoxide, lead dioxide, or lead chromate; No. 2,726,944—up to 10 per cent lubricant, 30-90 per cent barium peroxide, the remainder being chromium monosulfide, chromium tetrasulfide, or selenium sulfide.

Jet Stability.—*U. S. Patent No. 2,721,045. Issued October 18, 1955, to Willard R. Custer:* The object of this invention is to improve the stability of jet-propelled aircraft during the critical periods of takeoff and landing. It is accomplished by providing an extendable Custer channel mounted in the leading edge of a jet tube in the fuselage, as shown in Figure 1.

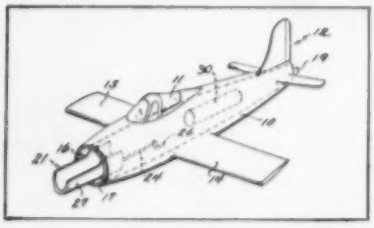
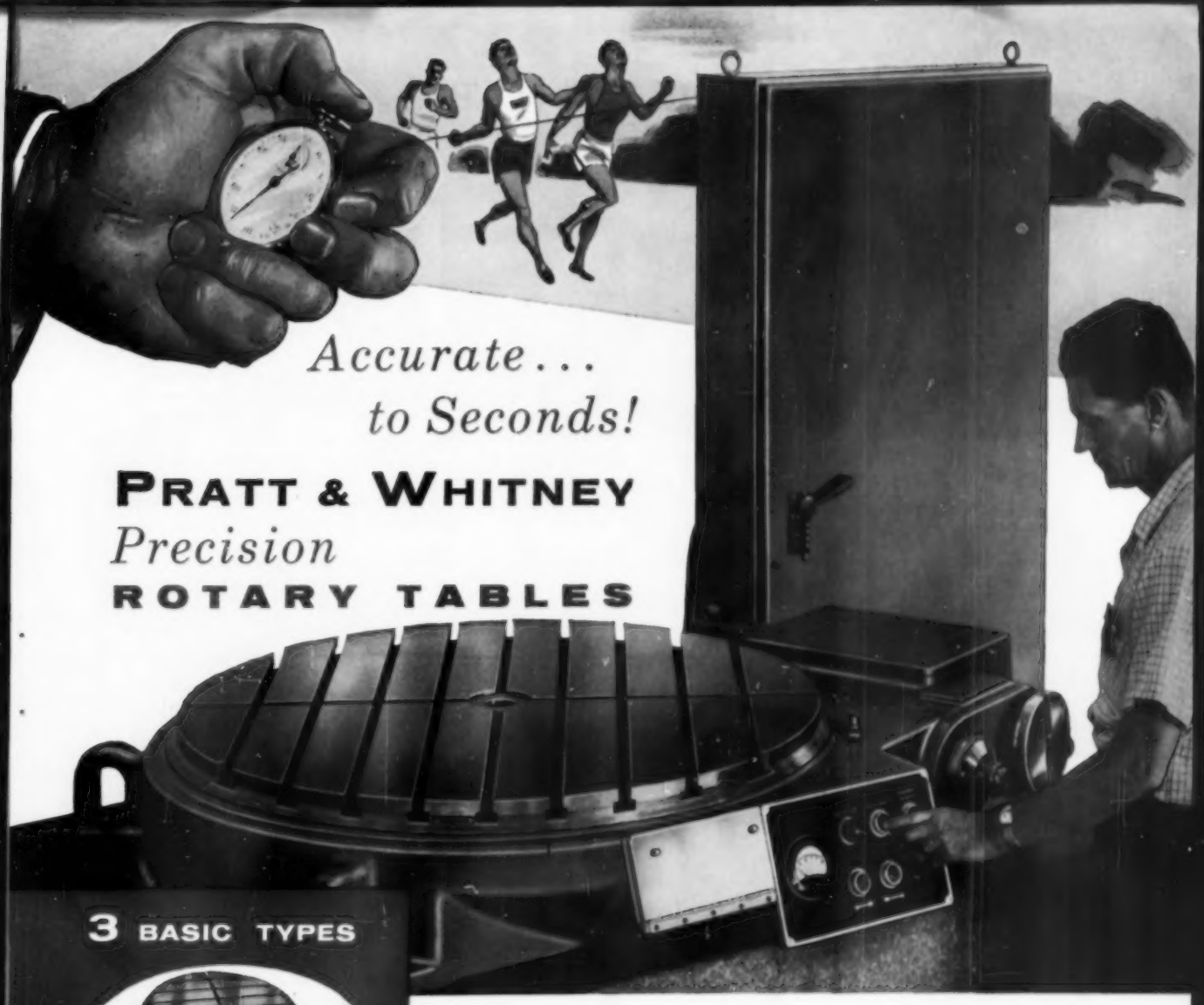


Fig. 1. Extendable channel in jet intake.

Drag Reduction in Missiles.—*U. S. Patent No. 2,727,706. Issued December 20, 1955, to Louis F. Heilig. Assigned to Northrop Aircraft, Inc.:* It is well known that the surface contour of an aircraft for maximum efficiency and minimum drag is different at low and high speeds. The rounded leading edge is best for take-off and low speeds, while at speeds in the supersonic range a sharp leading edge is desirable. In the case of guided missiles, where no safe landing problem exists, it is possible to convert a rounded leading edge to a sharp leading edge during flight. In the patent, a member such as a wing section or the lip of the air intake is provided with a permanent surface with a sharp leading edge. This permanent contour is modified before flight by an overlay which temporarily maintains a rounded leading edge. During flight, as the temp-



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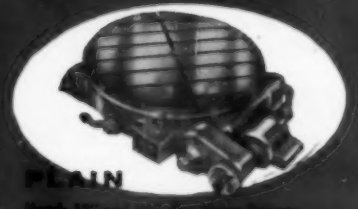

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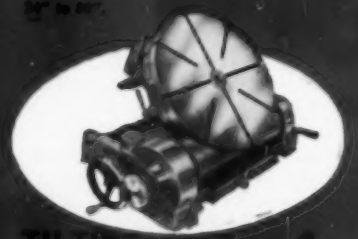

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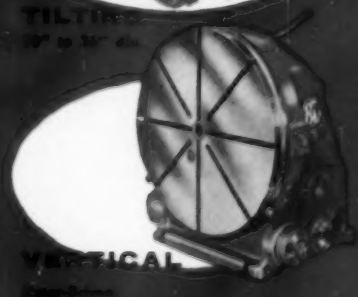

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Recent Patents (Contd.)

erature increases due to aërodynamic heating, the overlay becomes detached because of the melting or softening of the overlay material. Low-melting alloys or certain waxes are recommended for the overlay.

Cargo Helicopter Team.—*U. S. Patent No. 2721044. Issued October 18, 1955, to Raymond A. Young. Assigned to the Secretary of the Navy:* The object of this invention is to permit teaming of two or more conventional helicopters together to realize the required total lifting capacity required to move loads that are too heavy for a single helicopter to handle. A limited amount of flexibility of relative motion of the helicopters with respect to each other is permitted to compensate for peculiarities of each in flight.

Flight-Control Apparatus.—*U. S. Patent No. 2726510. Issued December 13, 1955, to Robert H. Goddard. Assigned in part to the Daniel and Florence Guggenheim Foundation:* Four auxiliary combustion chambers are provided for steering a rocket-propelled aircraft. Two of these 20, 20a are shown in Figure 2, the other two being in a perpendicular plane. Gasoline and oxygen lines 25 and 26 lead to each of the auxiliary jets. Valves divert the flow of fuel and oxygen to one or another of the jets 22 as desired, thereby steering the rocket. The valves are operated through flexible bellows by means of liquid oxygen.

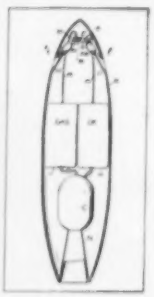
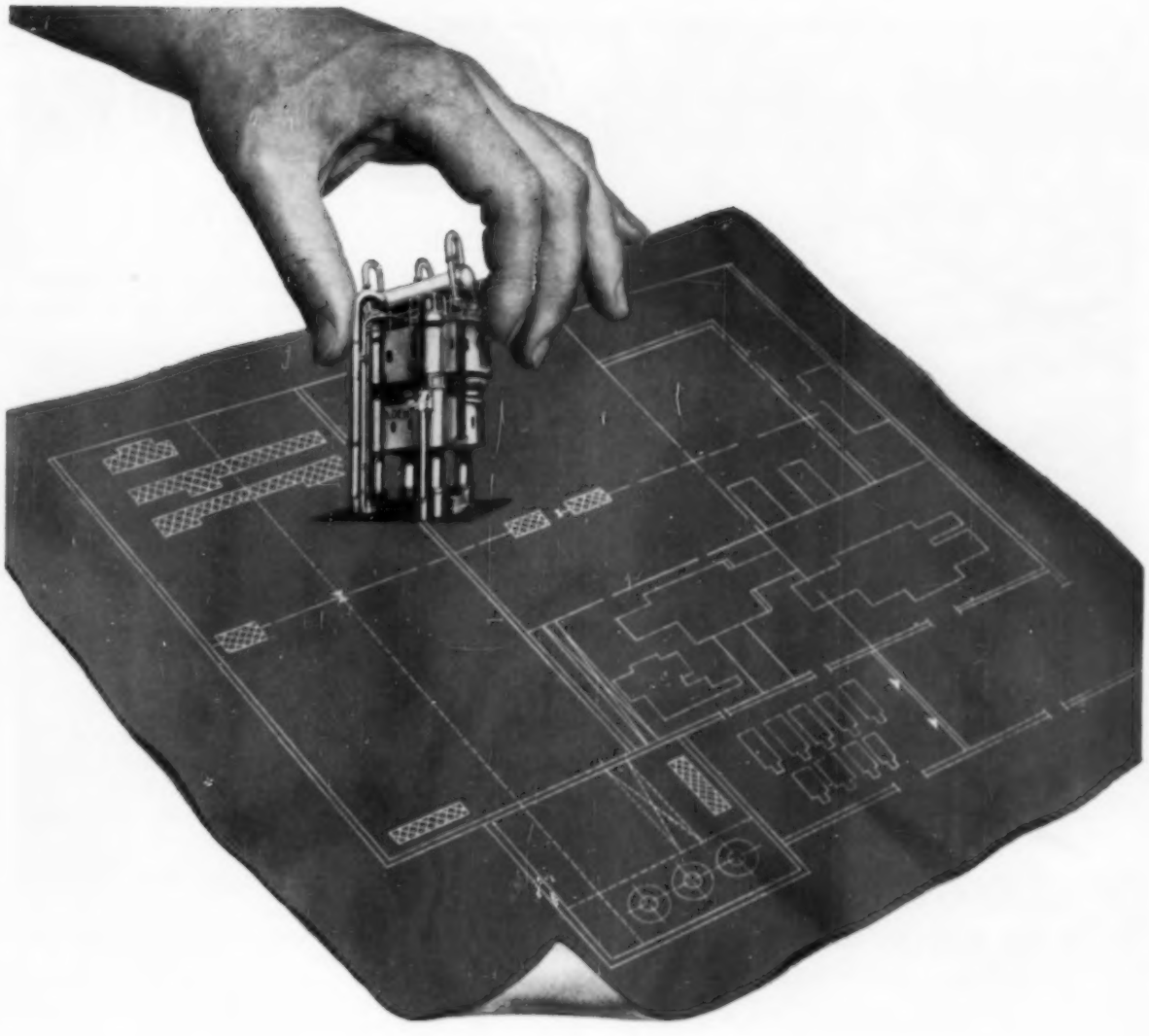


Fig. 2

Magnetic Torpedo Catcher.—*U. S. Patent No. 2722, 192. Issued November 1, 1955, to Harry H. Hoke, Jr.:* This invention provides a safety device for vessels so that, in case of a torpedo attack, the torpedo can be trapped until the energy of its propelling motor is used up, and it then is allowed to drop back into the sea to sink. The torpedo is caught and held at points outside the area of the detonating pin in order to prevent explosion. The essential elements of the invention are an impact or arresting member and diverting members. The upper member functions also as a platform.

The two diverting members and the hull constitute the three sides of a triangular housing in which are placed a number of tandem propellers. Below the platform member is a compartment, the purpose of which is to house electromagnets. The magnets are so arranged that they tend to cause the torpedo to align itself as shown, and eventually to roll off the platform into the sea.



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Book REVIEWS

Reviews in this issue by:

CAPT. U. S. BRADY, JR., U.S.N., *program director, guided missiles and electronics, Planning and Progress Division, Navy Bureau of Ordnance, Washington, D. C.*

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

DR. JAMES B. EDSON, *consultant on electronics, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

PHILIPPE W. NEWTON, *deputy chief, guided-missile section, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C.*

BRIG. GEN. THOMAS K. VINCENT, U.S.A., Ret., *artillerist, engineer, author, Washington, D. C.*

Guided Missiles in War and Peace. By Nels A. Parson, Jr. Cambridge, Mass.: Harvard University Press. 161 pp. $3.50.

IN these days of public debate and promotional publicity on guided missiles the vast majority of the audience, military and civilian, including the debaters and publicists, are at a loss to understand the terms with which they are confronted.

Major Parson has dipped into the mass of data available on these fascinating weapons and has produced a very readable book. While the nontechnical reader may bog down momentarily in a few spots, these pass quickly without discouragement.

The book is an excellent combination of historic background, military applications, and a glance into the crystal ball of things to come, including a trip to Venus.

On one subject the author seems to struggle with his convictions. Early in the book he states, "There will always be a need for piloted aircraft. No mechanism can duplicate the ability of the human being to reason and to use good judgment." But before the book is finished there is a distinct impression that the surface-to-air missile will outdo the piloted interceptor and that the surface-to-surface missile offers many advantages over the manned bomber.

This situation does not exist today, but when the same amount of time and effort has been spent on missiles as has been put to bringing combat aircraft to their present state of high performance, it seems inevitable that the missiles will forge ahead.

For any one wanting a short and pleasant course in guided missiles, Major Parson has prepared the text.—U. S. BRADY, JR.

Night Raider of the Atlantic. By Terence Robertson. New York: E. P. Dutton & Company. 256 pp. $4.

THE German bid for sea superiority was based on her submarine tactics. The daring commander of U-99, Otto Kretschmer, evolved unusual tactics in combat with his U-boat and was the first of that small group which sunk 250,000 tons of Allied shipping. Each exploit is covered in some detail, and the descriptions of the close brushes the U-99 had with defeat are vividly told.

The gentlemanly actions of its commander and crew are not in keeping with the usual picture one gets of the German oppon-

(*Continued on page 1036*)

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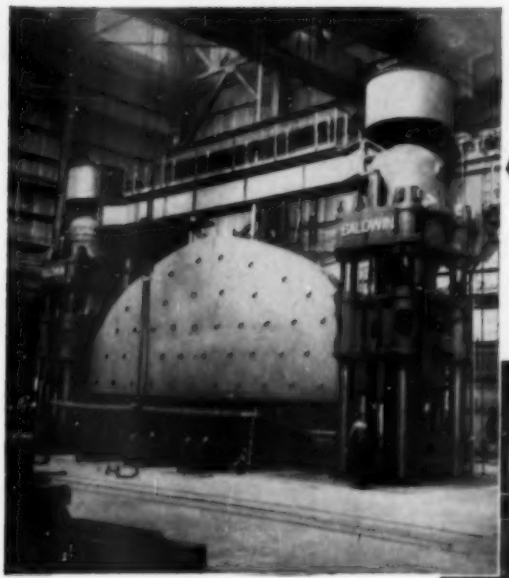

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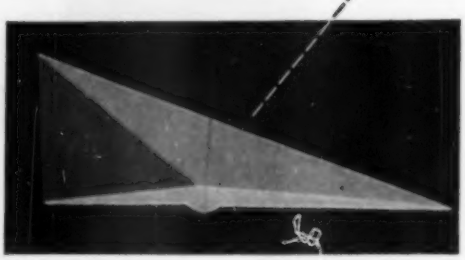
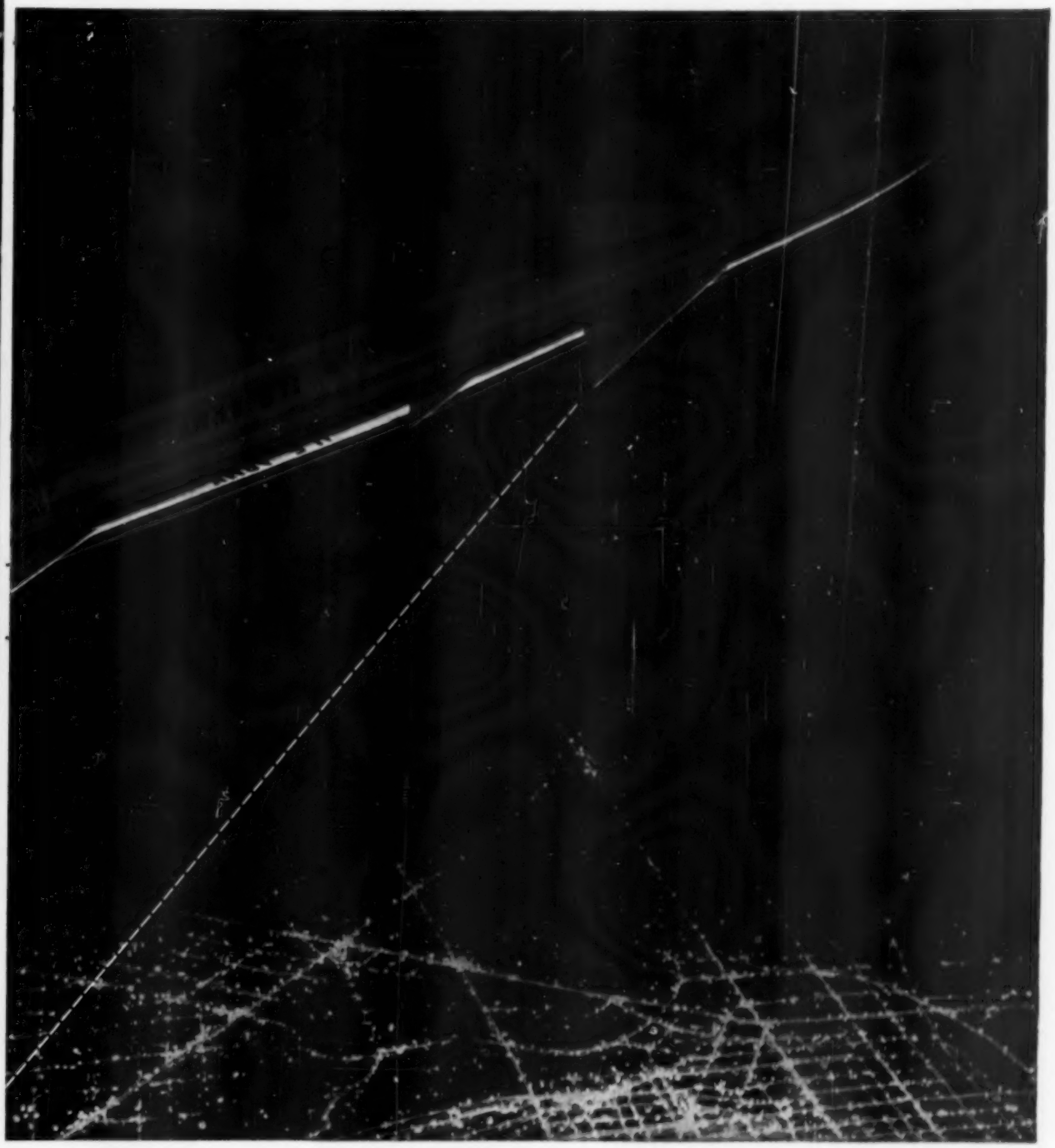
Width	±1/32"	Straightness	.010" in 10" length	Local depressions	.005" per inch length .015" maxm. depth





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ent but conforms to the customs and practices of navy men the world over.

This book, like many now appearing, would indicate that the vanquished produced many individual heroes but that the Allies were led by officers who were conformists, with few exceptions. One wonders where the stories of the exploits of our American and British naval commanders are hidden.

Nevertheless, this book, with its preface by Adm. Sir George Creasy, is worthy of a place in one's library and contains a fascinating story.—THOMAS K. VINCENT.

Electrons, Waves, and Messages. By John R. Pierce. New York: Hanover House. 318 pp. $5.

THIS book invites active "reader participation" through the experience of scientific thought in terms of simple mathematical expressions. The author first explains the rudiments of algebra and of Newtonian mechanics. Halfway through the book, in "Maxwell's Wonderful Equations," he is casually explaining and using contour integrals and partial derivatives.

The whole thing is made so insidiously simple that a serious-minded high-school student might begin to comprehend and think in terms of Maxwell's equations without ever discovering that he isn't supposed to do such things!

After a lively survey of modern electronic concepts and devices, Pierce sweeps on to the domain of information theory. A chapter on "The Unexpected" describes the use of statistics to generate English prose and to compose "authorless" music. Examples and simple instructions are included.

The final chapter, "The Future," points out that we must not be fascinated by our own extrapolations of the present; we must learn to expect the unexpected.

The whole book is sprinkled with that mighty mixture of stardust and algebra which is the spirit and discipline of engineering science. It can bring pleasure and profit to all who want a clear, intimate glimpse into the electronic world.—J. B. EDSON.

The Birth of the Bill of Rights. By Robert Allen Rutland. Chapel Hill, N. C.: The University of North Carolina Press, 243 pp. $5.

DECLARATIONS of rights were not new in the American Colonies previous to the Revolution, but from 1776, when the Virginia Bill of Rights was adopted, to the final adoption of a Federal Bill of Rights in 1791, there was a long wordy struggle to ensure protection of the personal rights of the people from the power of the Government, whatever the nature of that Government might be.

In France, François Rabelais had written that "the law courts are like cobwebs, catching and destroying the small flies but being broken and stretched by the big beetles."

One thing that perhaps is not too well appreciated today is that the American Colonists were not merely fighting to free themselves from the rule of a king. The founding fathers of the American Republic were determined that they would free the people forever from the arbitrary injustices that were then characteristic of European court systems.

The State conventions looked upon a bill of rights as more fundamental than a constitution. In North Carolina the delegates were specifically enjoined to seek a bill in strict conformity with the maxim that the people are the source of all power and to express rights of the people which could never be enfringed by any constitution in any future time.

The author of this book has made the men of 1776-1791 live and speak to the

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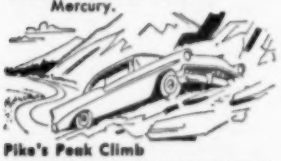
1953—Lincoln, 1st, 2nd, 3rd, 4th, 7th, 8th and 9th places.
1952—Lincoln, 1st, 2nd, 3rd and 4th places.

Stock Car Races
1955—30 races won by Chevrolet, 5 races won by Ford Thunderbird.
1954—24 races won by Hudson Hornet.
1953—47 races won by Hudson Hornet.

Mobilgas Economy Run
1955 Sweepstakes Winner—Studebaker.
1954 Sweepstakes Winner—Studebaker.
1953 Sweepstakes Winner—Ford 6.
1952 Sweepstakes Winner—Mercury.



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Book Reviews (Contd.)

present generation. One need not be a lawyer to read and understand this book. Christopher Gadsden, of South Carolina, said that "it is essential to a Republic to have its laws plain and simple." Their arguments as brought out in this book were plain and simple and, because of their simplicity, were very forceful.

In these times, when such a vast proportion of the population of the world is compelled to live under the control of governments without the protection of a bill of rights, and when so many misguided people seem desirous of increasing the power of government, it is more than ever necessary that we have an understanding of the arguments which the founders of this Republic made so clear. Every American should read this book.—GEORGE S. BRADY.

The Web of Victory—Grant at Vicksburg. By Earl Schenck Miers. New York: Alfred A. Knopf. 320 pp. $5.

DESPITE the spate of Civil War books, every new one (if it is a good one) offers a fresh viewpoint and more information on a conflict which is being studied today as never before. This one is of real value and it is highly readable. Written in a news style, it seems quite gossipy. But can it not be truthfully said that the Civil War was largely run on gossip?

Possibly its weakest point is the lack of adequate maps; there are but three and these are not very detailed nor do they cover quite enough terrain. The primary purpose of the author has been to give a study of General Grant's character, especially its growth. Vicksburg is surely the proper choice, for prior to this it was unformed; afterward it changed but little.

Grant's fight against being shackled by "higher authority" was as important to his task as was his fight against Pemberton and Johnston. He won it, and thus the campaign. Much light is shed on Grant's subordinates. He did much to change Sherman from a nervous wreck to a victorious leader, and his patient handling and quiet disposal of the egregious McClernand probably helped President Lincoln decide on Grant for future work.

Ordnance is far better recognized by numerous notes and details than in most volumes of military history. It can be highly recommended for a fresh, brief, and entertaining view of the campaign which broke the back of the Confederacy. —F. W. FOSTER GLEASON.

Men, Rockets, and Space Rats. By Lloyd Mallan. New York: Julian Messner, Inc. 335 pp. $5.95.

THE author is an aviation enthusiast and, with his wife as a teammate, turns out dramatic prose. The research for data on which this book is based was terrific, involving thousands of miles of travel, endless interviews, and the searching questioning and cross-examining of many sometimes reluctant witnesses. Out of it has evolved the story of the accomplishments in rocket development, all devoted to the idea that space flight may be possible and outer space may be conquered by men from this old earth of ours.

It is a story built around the United States Air Force and the principal participants in these many-angled facets of the space-flight activity. The past is given the light-brush treatment, the present is treated fully, and the future is unhesitatingly painted broadly in glowing colors.

The book is built around people. Their particular achievements and fields of endeavor are woven into chapters, each of which could be expanded into a book, having intriguing titles such as "Faster than a Shriek!" "Blossoms and Aërobees," "Monkeys and Space Rats," and "Listening to a Star." One finds that such are woven around the exploits of men like Lieut. Col. John Stapp, Maj. "Chuck" Yeager, Dr. John Evans, and others.

The foreword is by Lieut. Gen. T. S. Power, Commander, Air Research and Development Command. An excellent glossary of aërodynamic and space terms and an index complete the book—T. K. VINCENT.

Aircraft Gas Turbines. By C. W. Smith. New York: John Wiley & Sons, Inc. 448 pp. $8.75.

FOR over thirty years an engineer and educator on the staff of the General Electric Company, and for the past ten years adjunct professor of aëronautical engineering at New York University, Dr. Smith brings to the subject considerable experience in the theory and practice of aircraft gas turbine engineering.

Addressing itself mostly to the practicing engineer and the graduate student, with emphasis on theory, this volume carefully avoids the lengthy descriptive material that technical progress quickly makes obsolete. It is a coherent, logical, and concise presentation of the aërodynamic, thermodynamic, and mechanical fundamentals of jet propulsion.

The first chapters of the volume cover the basic aspects of the gas-turbine cycles, gas dynamics, and flow theory without recourse to any but the simpler mathematical tools. The second and main part contains an exhaustive treatment of the propulsion system: intake and exhaust, centrifugal and axial-flow compressors, the turbine, and the combustion chamber.

The final chapters include some elements of power-plant performance analysis, control and accessories, materials, and

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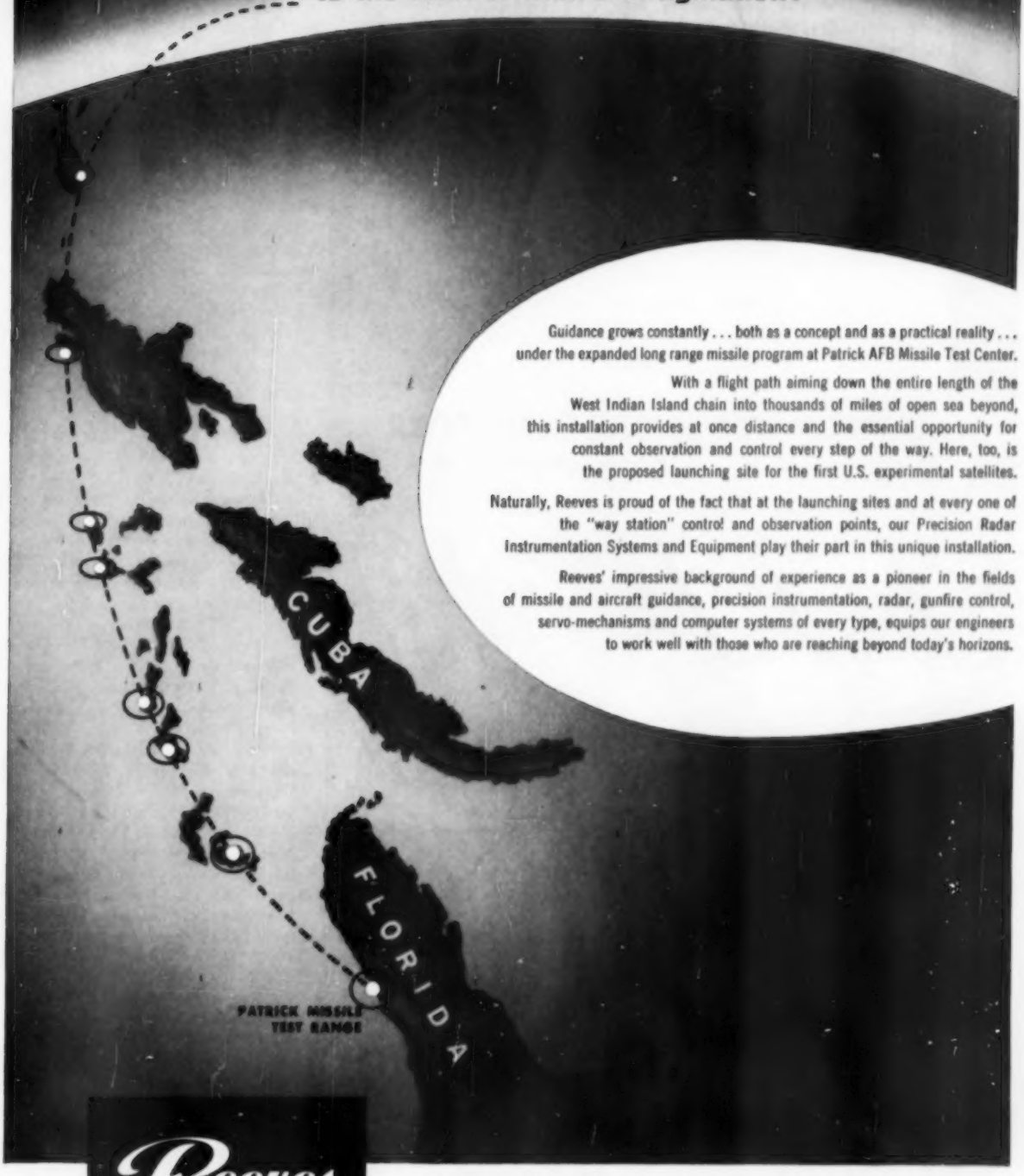

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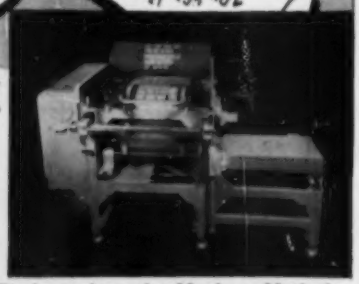

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Book Reviews (Contd.)

installation. A selective bibliography is added. The book somewhat suffers from the lack of numerical examples and no problems are given.

In summary, the volume is a well-rounded and clear introduction to gas turbines, containing a great deal of information never before assembled in a book of its size. It is the latest addition to the General Electric series.—PHILIPPE W. NEWTON.

BOOKS RECEIVED

Across the High Frontier: The Story of a Test Pilot, Maj. Charles E. Yeager, USAF. By William R. Lundgren. New York: William Morrow & Company. 288 pp. $3.75.

Aircraft Today. Edited by John W. R. Taylor. New York: Philosophical Library. 96 pp. $4.75.

Antigalling Coatings and Lubricants for Titanium. Titanium Metallurgical Laboratory (TML) Report No. 34, February 24, 1956. Columbus, Ohio: Battelle Memorial Institute. 54 pp. NP.

ASTM Specification for Steel Piping Materials. Prepared by ASTM Committee A-1 on Steel. Philadelphia: American Society for Testing Materials. September 1955. 432 pp. $4.

Beta Transformation in Titanium Alloys. TML Report No. 25. December 5, 1955. Columbus Ohio: Battelle Memorial Institute. 142 pp. NP.

Effect of Hydrogen on the Properties of Titanium and Titanium Alloys. TML Report No. 27, December 27, 1955. Columbus, Ohio: Battelle Memorial Institute. 84 pp. NP.

Farewell to Boom and Bust. By Henry Kimball Loud. New York: Pageant Press. 170 pp. $2.50.

Flow Properties, Deformation Textures, and Slip Systems of Titanium and Titanium Alloys. TML Report No. 30, January 31, 1956. By F. C. Holden, D. N. Williams, W. E. Riley, and R. I. Jaffee. Columbus, Ohio: Battelle Memorial Institute. 108 pp. NP.

History of the Croatian People. By Francis R. Preveden. New York: Philosophical Library. 96 pp. $7.50.

History of the United States Naval Operations in World War II. Vol. 9. By Samuel Eliot Morison. Boston: Atlantic-Little, Brown & Company. 413 pp. $6.

Institution of Mechanical Engineers, Proceedings of the Automobile Division, 1953-1954. London: Published by the Institution. 151 pp. NP.

Kill or Get Killed. Manhandling Techniques for Police and the Military. By Lieut. Col. Rex Applegate. Harrisburg: Military Service Publishing Company. 332 pp. $3.

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PEELER
Model 6115

Trademark of Quality Hobart for over 55 years

Hobart machines

The World's Largest Manufacturer of Food, Kitchen and Dishwashing Machines

. . . And ever wonder why?

There are as many reasons as kitchen operators you talk to. But every one of them adds up to many reasons for *you*. Here's why you see one, many, or *all*-Hobart installations everywhere!

THE DESIGN—Hobart leads the industry in cleanness and design—in rugged, plus-powered performance. For over a half-century, Hobart has consistently worked with the food service industry to produce the machines *you* tell us that you need.

FULL-LINE SATISFACTION—Hobart can completely outfit you with food, kitchen, bakery, and dishwashing machines—plus food waste disposer units. You plan installation, finance and service through a single source. Widest choice of models and capacities.

THE GUARANTEE—All Hobart products are guaranteed by Hobart, and this guarantee of quality has stood as the industry standard since before the turn of the century.

THE SERVICE—Hobart service is as near you as your nearest Hobart representation—and that is nationwide; in fact, world-wide.

That's what your colleagues tell us—why their purchases have made Hobart the world's oldest and largest supplier of machines of this type. We'd like to prove it to you—as a customer. Send the coupon and see for yourself . . . ***The Hobart Manufacturing Company, Troy, Ohio.***

THE HOBART MANUFACTURING COMPANY
Troy, Ohio • Attention: Dept. Adv.

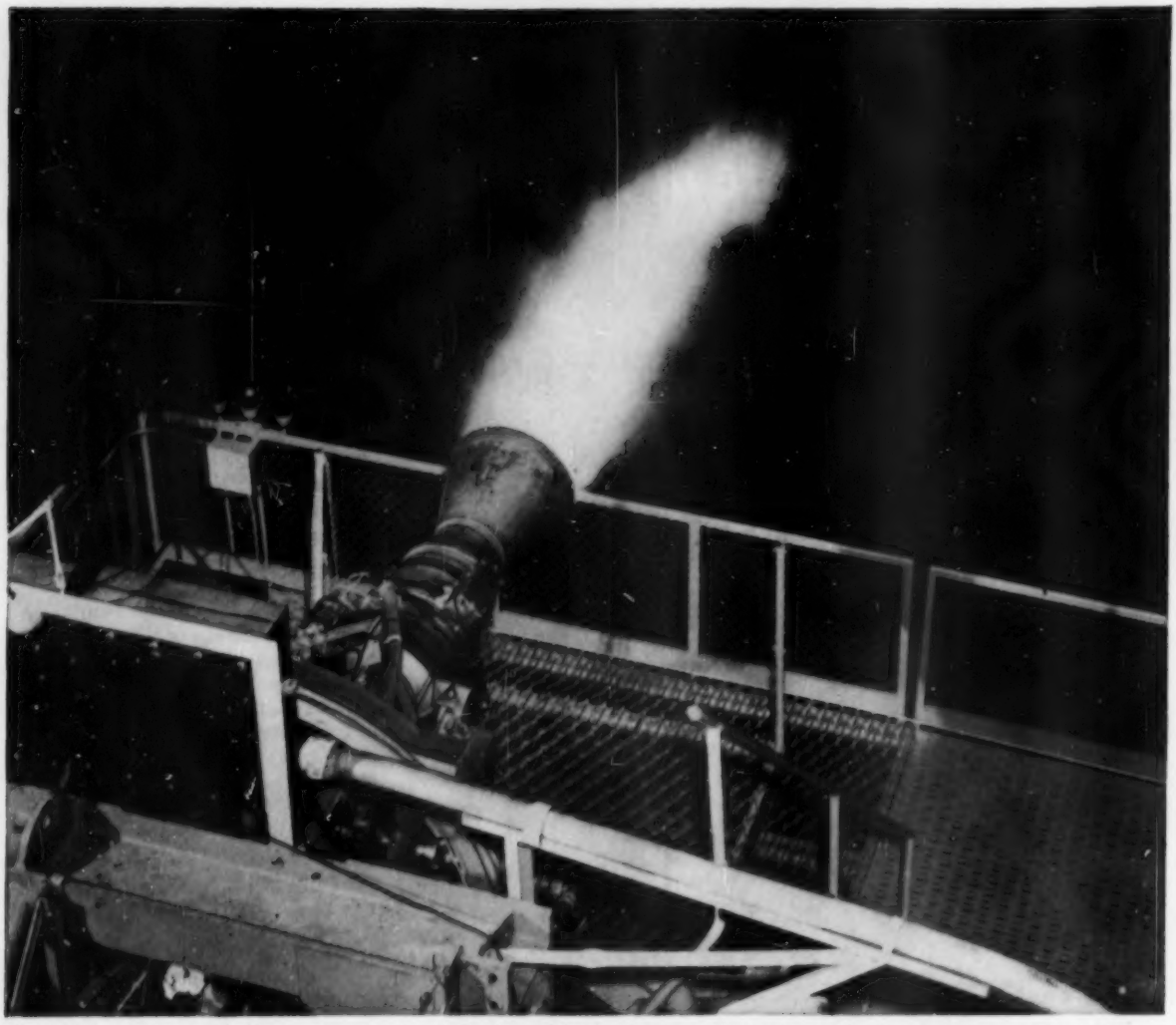
Please send me Hobart information.

NAME_____

BUSINESS_____

STREET_____

CITY_____ ZONE____ STATE_____



Night firing tests on early ROCKETDYNE engines helped speed the development of today's models whose power cannot be disclosed.

Today's Rocket Engine can send a missile half-way around the earth

Even as you read this, rocket engines capable of sending a guided warhead half-way around the earth are being developed and produced by ROCKETDYNE, a Division of North American Aviation, Inc. . . . and larger, still more powerful units are on the way.

Behind these bare facts is a 10-year story of how the Air Force and ROCKETDYNE faced up to one of the biggest engineering challenges of the last decade. Security restrictions do not permit us to give you the details, but we *can* tell you that ROCKETDYNE has manufactured the largest liquid-propellant rocket engine in the free world. ROCKETDYNE is developing and producing rocket engines for many of the major guided missile projects in this country.

If you are an engineer—and interested in this young and challenging field—write ROCKETDYNE, Personnel Manager, Dept. O-2, 6633 Canoga Ave., Canoga Park, California . . . located near Los Angeles in the West San Fernando Valley.

ROCKETDYNE *A Division of North American Aviation, Inc.*

BUILDERS OF POWER FOR OUTER SPACE

For less than *a day!**

REGULAR A.O.A. MEMBERS RECEIVE MORE—

- ORDNANCE, the bimonthly journal of scientific and industrial preparedness.
- THE COMMON DEFENSE, the Association's monthly newsletter.
- INDUSTRIAL PREPAREDNESS—a bimonthly report on the activities of A.O.A. Technical Committees and Divisions (available on request).
- Membership in a local A.O.A. Post with its attendant activities.
- Other benefits and services including the Ordnance Book Service, embossed membership card, privilege of wearing insignia, special reports, plant visits, seminars, national meetings, dinners, and conventions.

AND PAY LESS THAN EVER BEFORE—

$5 annual dues in 1920

$4 annual dues in 1930

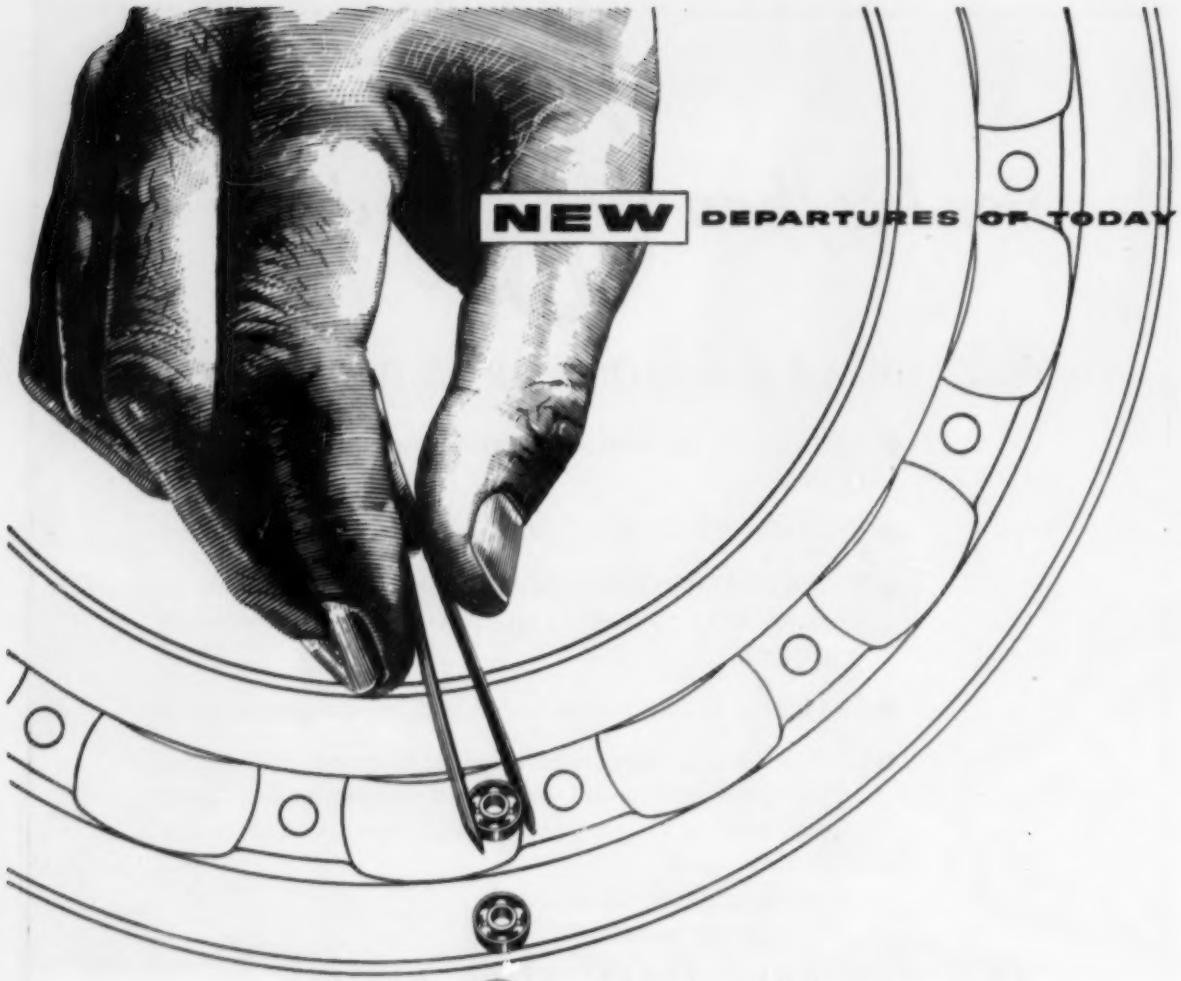
only $3.33 *a year today!*

*(at the special rate of three years for $10.00)

WHY NOT TELL A FRIEND ABOUT THE A.O.A. TODAY?

American Ordnance Association

708 Mills Building, 17th and Pennsylvania Ave., N.W., Washington 6, D.C.



From the expanded facilities of New Departure... a complete line of miniature bearings!

The most exacting needs of today's precision industries are met by New Departure's complete line of miniature ball bearings, 3/8" (.375") outside diameter and smaller.

Made with extreme accuracy, these tiny steel "jewels" are assembled, torque-tested, and packed in pressurized, atmosphere-conditioned areas of surgical cleanliness, assuring performance and dependability of the highest order.

For full information about miniature bearings, or for engineering help on your bearing problems, contact New Departure, Division of General Motors, Bristol, Conn.

GM GENERAL MOTORS

NEW DEPARTURE BALL BEARINGS

NOTHING ROLLS LIKE A BALL

minute men

WHEN SECONDS MEAN SURVIVAL, ground support equipment of unquestionable reliability is the indispensable factor. As a pioneer in all phases of ground support, CONSOLIDATED has developed units of broad application for maintaining missiles or piloted aircraft at a constant ready. Through design, development and manufacture, we have solved the most complex problems of providing self-propelled, multi-purpose units . . for towing, testing, servicing and starting guided missiles and jet aircraft . . . . . quickly, surely and under the most difficult operational conditions. Several of CONSOLIDATED's models are now being used extensively by the U. S. Air Force, Navy and Marines.

MODEL 2100 INCORPORATES HYDRAULIC, A. C., D. C. ELECTRIC, AND TOWING.

IN THE EXACTING FIELD OF GROUND SUPPORT, CONSOLIDATED HAS DEMONSTRATED ITS ABILITY TO MEET THE MOST COMPLEX DEMANDS

CONSOLIDATED
DIESEL ELECTRIC CORPORATION

STAMFORD, CONN. BRANCHES · DALLAS, TEX. · DAYTON, OHIO · SANTA ANA, CAL. · WASHINGTON, D. C.
IN CANADA · CONSOLIDATED DIESEL ELECTRIC CORPORATION · OTTAWA, ONT.

TOWING TRACTOR

CRANE TRUCK

ORDNANCE...

LIFT TRUCK

BOMB CARRIER

CRASH TRUCK

GENERATOR TRUCK

● These aircraft service vehicles are typical of the wide variety of rolling stock that rides on TDA axles, is driven by TDA components, and stopped by TDA brakes. Time and again, TDA experience has proved invaluable in improving the efficiency and economy of such equipment as that shown here.

REFUELER

IS OUR BUSINESS

...for 40 years, the armed forces...land, sea and air... have been key customers of Timken-Detroit.® Supplying parts for military rolling stock has been part and parcel of our day-to-day operation!

For almost half a century, TDA® has been the nation's leading producer of axles for trucks and other heavy equipment. During that time, no small part of our production has been for America's defense program. Enormous facilities, vast engineering experience, and rigid manufacturing standards, qualify TDA to build components that will meet the most exacting demands. (A typical TDA assignment was the design and construction of axles to carry the massive Atomic Cannon for the U.S. Army.)

Today, Timken-Detroit manufactures a long and diversified line of heavy-duty axles, brakes, transfer cases, and other automotive equipment. Frequently, a part considered "special" is already available as a standard TDA product. In other cases, TDA engineers can simplify and reduce the cost of building custom components. Inquiries on all problems involving the building of ordnance rolling stock are welcomed by TDA's technical staff. We feel privileged to share in America's defense program and are eager to offer our experience to help develop better and better equipment.

TIMKEN Detroit AXLES
TIMKEN DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN
The Accepted TDA Standard
TRADE MARK REGISTERED

World's Largest Manufacturer of Axles for Trucks, Buses and Trailers

●

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica New York • Ashtabula, Kenton and Newark, Ohio New Castle, Pennsylvania

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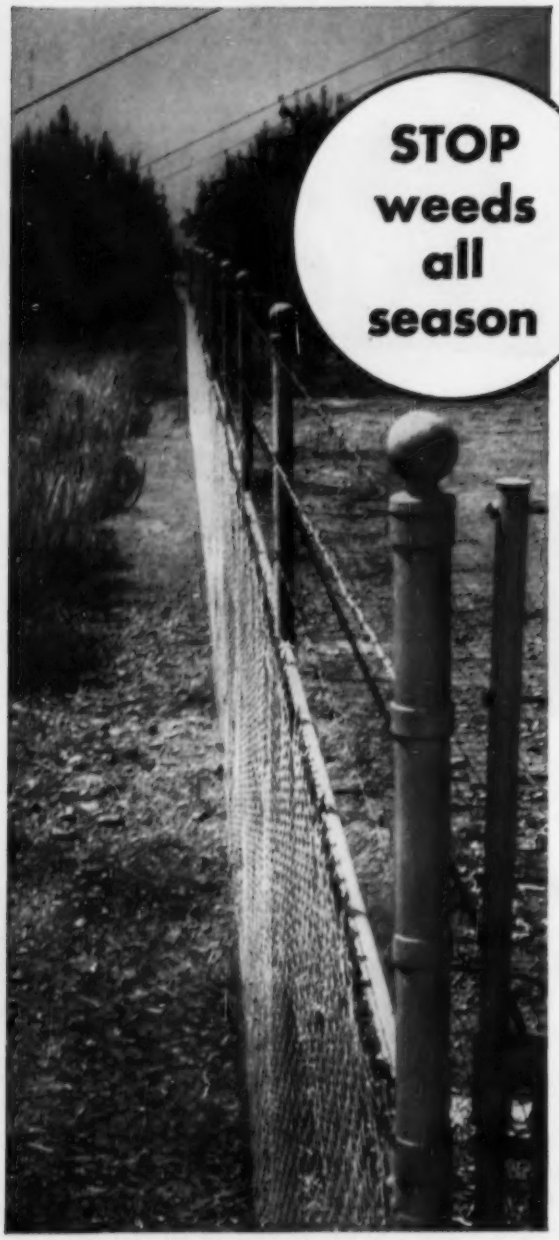


Just one application of "Telvar" controlled weeds around this security fence. Note the type of vegetation involved in untreated area at left. "Telvar" is ideal for weed control around fences, railroad sidings, buildings and installations of all types.

FREE ILLUSTRATED BOOKLETS describe how to control weeds and brush with Du Pont chemicals. Write to Du Pont, Grasselli Chemicals Dept., Rm. D-4032, Wilmington, Del. In Canada, Du Pont Company of Canada Limited, 80 Richmond Street West, Toronto, Canada.

Spray just once with Du Pont TELVAR®

WEED KILLERS

When you use "Telvar" weed killers, vegetation is killed through the roots and regrowth is prevented because the chemical remains in the soil . . . provides residual action all season long. And low dosages (1 to 1½ lbs. per 1,000 sq. ft.) make it cost little for the results you obtain. Such low rates also mean less handling, less use of storage facilities.

"Telvar" weed killers come as wettable powders, are non-corrosive, non-flammable, non-volatile, low in toxicity to humans and livestock.

Include "Telvar" weed killers in your weed-control program this year. Prove to yourself how these products of Du Pont research can help cut your maintenance cost to new low levels.

• • •

Where brush is a problem, Du Pont Ammate® X weed and brush killer is the product you need. It kills more kinds of brush with unusual safety. With ordinary precautions, "Ammate" X may be used close to such crops as cotton, tomatoes, soybeans and peanuts.

On all chemicals, follow label instructions and warnings carefully.

DU PONT
REG. U. S. PAT. OFF.

WEED and BRUSH KILLERS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

For longer life in rugged duty... Air Force work horses now depend on Cline's wide-frequency-range

EXCITER VOLTAGE REGULATORS

The USAF B-1 alternator used on T-29, C-97 and C-124 aircraft is now controlled by Cline's Wide-frequency-range (380-1000 cycles) *Magnetic Amplifier Exciter Voltage Regulator.*

Most of the Magnetic Amplifier Voltage Regulators flying today are Cline-built. Each regulator has logged far more hours of trouble-free flying time than any other aircraft voltage regulator.

Cline's new Exciter Voltage Regulator has not only proved itself but, along with Cline's *Magnetic Amplifier Speed-Positioning Devices,* has proved Cline's ability to handle other complex electronic control problems.

Cline Electric also manufactures 20MM Aircraft cannon.

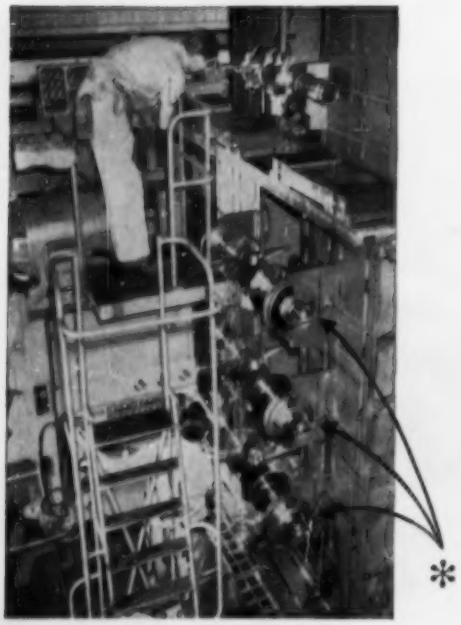
AIRCRAFT PRODUCTS DIVISION
CLINE ELECTRIC MANUFACTURING COMPANY
3405 West 47th Street Chicago 32, Illinois

Controls by

CLINE ELECTRIC

BUILDING PRECISION INTO TARGET ZERO

at CPT...A New Kellering



From the pattern at top, three aircraft landing gear axles are Kellered at one time. Axles being machined are indicated by asterisk.

● At CPT, we've installed eight BG-22, 3-spindle Pratt & Whitney Kellering machines. These 8 Kellers added to our single-spindle and two-spindle Kellers give us a total of 10 machines.

Each of the 3-spindle Kellers can produce three identical complex parts from a master... at the same time. Per-price cost is reduced, delivery is speeded, uniformity of contour and surface is assured. Even the most intricate and convoluted surfaces are accurately machined by tools that duplicate the contours of the master pattern.

In addition to the services of our battery of Kellers, CPT offers you the services of a complete collection of modern machine tools of all types: lathes, gap lathes, turret lathes, end mills, milling machines, grinders, hobbing machines, and thread grinders.

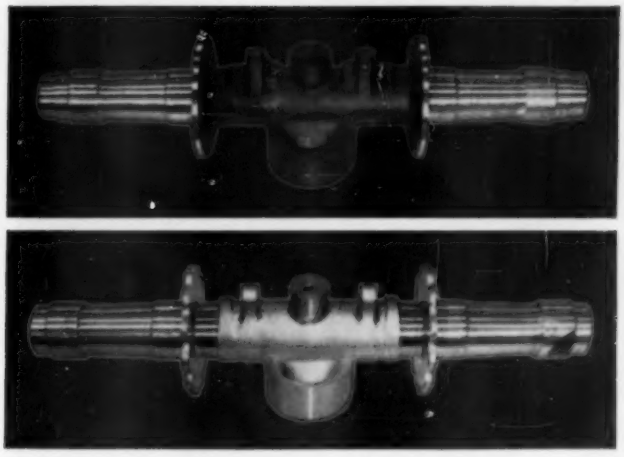
CPT

CLEVELAND PNEUMATIC

TOOL COMPANY • Dept. J-556 • Cleveland 5, Ohio

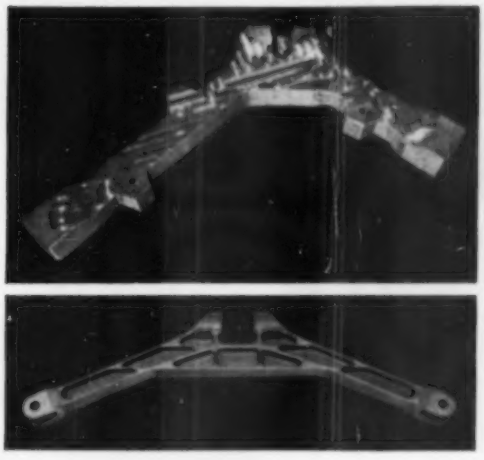
Sales-engineering offices in Seattle, Los Angeles, Fort Worth-Dallas, and Levittown, L. I.

CPT...world's largest and most experienced builder of landing gears and ball-screw mechanisms



General view of the Kellering Department at CPT, showing the 8 new 3-spindle Kellers.

Top photo shows an aircraft axle before it was Kellered. Bottom photo shows it after Kellering.



This aircraft structural part has been Kellered from a forging similar to the one shown at top.

Division is ready to work for you

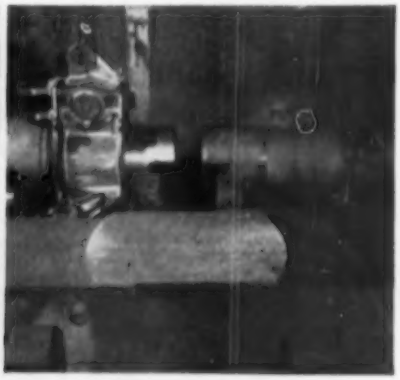
The world's largest flash-butt welding machine is also a part of CPT's facilities. Hollow steel sections up to 100 square inches in weld-face area are joined automatically and almost instantaneously.

Other facilities include batteries of heat-treating furnaces, magnaflux and zyglo inspection equipment and a Baldwin-Southwark testing machine with 1,000,000 lbs. capacity in tension or compression.

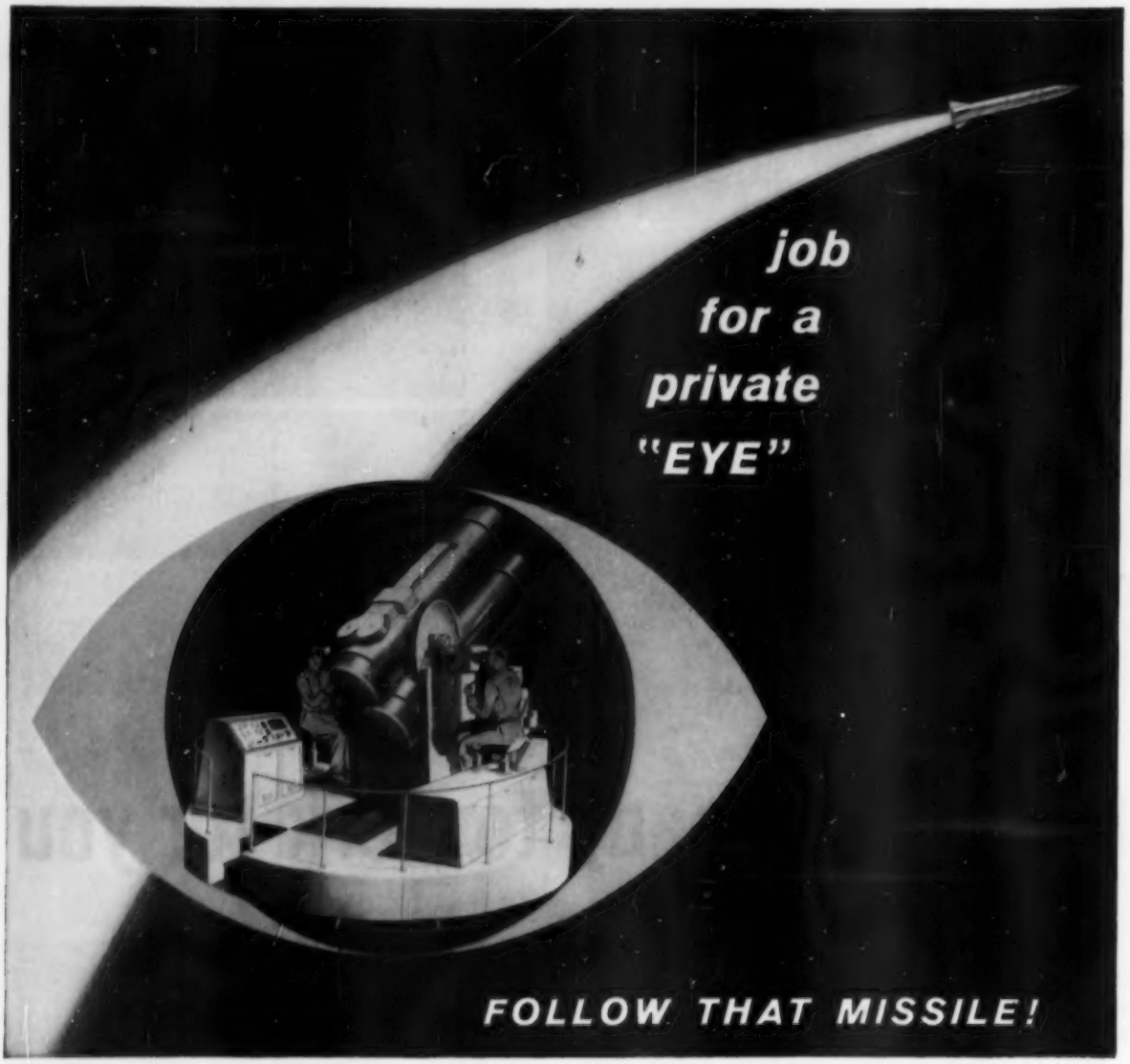
Before you invest in high-cost facilities and machines for your plant, investigate CPT's new Kellering Division's facilities that are supplemented by one of the most complete aircraft-quality production plants in the country. CPT also offers complete design and production engineering services.

Part of the battery of electric heat-treating furnaces at CPT. Pieces up to 13 feet long can be handled in these furnaces and quench tanks.

CPT's Baldwin-Southwark one-million-pound-capacity tensile testing machine can exert this pressure either in tension or compression.



Kellered head section about to be joined to cylinder tube by resistance welding on CPT's giant flash-butt welder.



Tailing an experimental missile in flight takes a special kind of "eye." Seconds after takeoff the missile has kicked through the sound barrier and receded to a fast-moving speck that registers no larger than a few thousandths of an inch in a telescopic field.

To help the Air Force track its missiles, Perkin-Elmer has developed ROTI Mark I (Recording Optical Tracking Instrument). ROTI provides an accurate photographic and magnetic tape record of the missile's flight. ROTI consists of twin 16" aperture telescopes having a range of 7 focal lengths from 50-500 inches, mounted on a large naval gun mount. When used in pairs, it records a missile's spatial position as a function of time with phenomenal accuracy. Velocity, acceleration and attitude can be derived for aerodynamic analysis.

ROTI is more than a precision instrument—it is a complex optical and electro-mechanical system. It was designed and built by an engineering staff with the technical scope and experience to take a systems problem and "see it whole."

Outstanding equipment developed and produced by Perkin-Elmer:

- **the Y-4 Bombing Periscope for the B-47**
- **prototype optical and radar bombing and navigation system now designated MA-2 for use on the B-52**
- **most large aerial photographic lenses in use today by the Air Force**
- **reactor periscopes for the Nautilus and Seawolf submarines**
- **airborne infrared detection systems for military use — these are the real "private eyes" from the security standpoint.**

In planning your next project, invite Perkin-Elmer to sit in. Our unique staff and facilities can bring your project to fulfillment sooner than you may now realize.

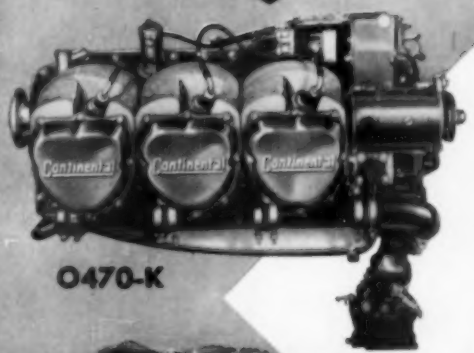
Perkin-Elmer
CORPORATION
NORWALK, CONNECTICUT

OPTICS • MECHANICS • ELECTRONICS

CONTINENTAL MEANS DEPENDABLE POWER

. . . PLUS THE BACKING OF ESTABLISHED AND EXPANDING SERVICE

C90



O470-K

GSO526

Continental's family of aircraft power plants—65 to 320 hp—is broader and more diversified today than ever before. Continentals give you dependability born of more than 52 years' engine-building experience, and backed by a steadily-growing network of ground facilities—factory-approved service and genuine Continental parts—all over the world, wherever people fly. Write for information.

	A65	C90	O300	*O470-K	O470-2	FSO470	GSO526
HP	65	95	145	230	265	260	320
RPM	2300	2625	2700	2600	2600	3000	3000
Cyl.	4	4	6	6	6	6	6
Wt.**	170	186.5	311	438	515	565	560
Fuel Octane	73	80	80	80	91/96	91/96	91/96

*Also available in 240-hp version as Model O470-M.

**Engine weight is complete with accessories.

CONTINENTAL MOTORS — Powerful as the Nation — AMERICA'S STANDARD

Continental Motors Corporation

AIRCRAFT ENGINE DIVISION

MUSKEGON • MICHIGAN

This Emhart catalog lists over 275 different machines- that's know-how we can use...
Let's get them then for that machine we've designed. It's ready to go.

For machine development and manufacture, see EMHART

It makes positive sense to put a certain machine building project into Emhart's hands. Each of the four divisions specializes in manufacturing machines. Each division is an acknowledged leader in its field. The combined experience of all four is probably unequalled in diversity.

Henry & Wright, for example, builds high speed machines for progressive metal stamping; V & O builds power presses and equips them in numerous ingenious ways; Hartford-Empire builds complete glassware production lines; and Standard-Knapp makes automatic packaging equipment.

Our central research and development group is available for consultation in Hartford or we can send a representative. If you would like more information, please write for our condensed catalog and literature describing Emhart facilities for defense requirements.

EMHART

CONTRACT MANUFACTURING DIVISION

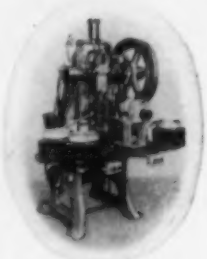
EMHART MFG. CO.

333 HOMESTEAD AVENUE, HARTFORD 2, CONN.

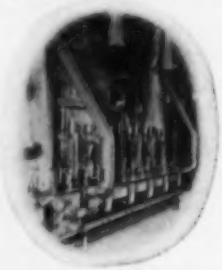
Only the best is good enough

PACKAGING MACHINES

POWER PRESSES



GLASSMAKING EQUIPMENT



HIGH SPEED METAL STAMPING MACHINES

EMHART DIVISIONS

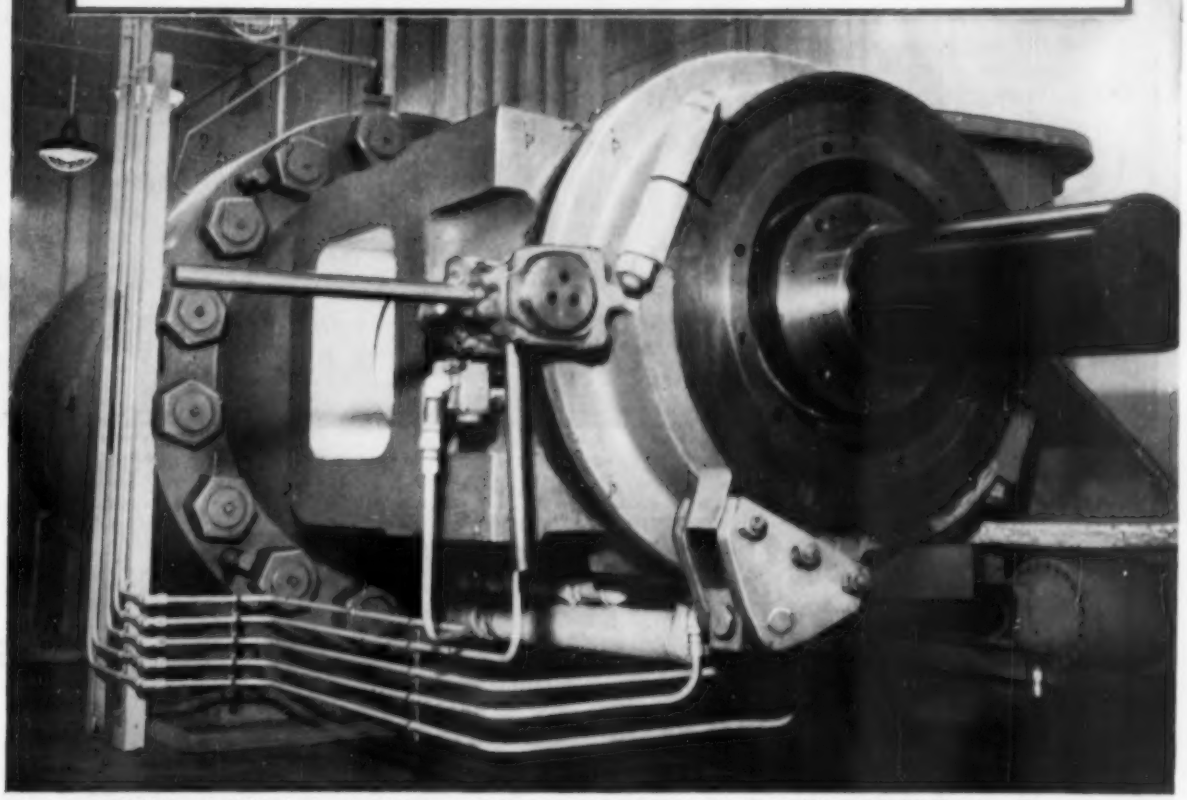
HENRY & WRIGHT
HARTFORD, CONNECTICUT

STANDARD-KNAPP
PORTLAND, CONNECTICUT

THE V & O PRESS COMPANY
HUDSON, NEW YORK

HARTFORD-EMPIRE COMPANY
HARTFORD, CONNECTICUT

NOW! Solid Rocket Propellants from PETROLEUM, by Phillips 66



Solid rocket fuel emerges from one of many extruders at Air Force Plant 66, McGregor, Texas

Phillips *66* scientists have put the low-cost energy of petroleum into power for rocket flight. Petroleum-derived materials including ammonium nitrate, synthetic rubber, and carbon black have been combined to produce a new solid propellant rocket motor meeting the most rigid USAF performance requirements without deviation. A family of Phillips propellants is available for use in rocket motors for JATOs, extremely large boosters, guided missiles, and other applications.

Phillips operates "Texas-size" facilities of latest design for rocket research, development, and production at McGregor, Texas. Our experienced staff is available to consult with the aircraft and missile industries on military problems and newer projects. We invite discussion of technical and production problems.

PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

Phillips 66

Address all inquiries to: **Rocket Fuels Division, McGregor, Texas.**

(Aluminum Company of America photo).

At one stroke this press can forge pieces 10′ wide or 24′ long. It can change a 2,000-pound aluminum slab into a complicated aircraft component... saving material as well as machining and assembly time. Cast and forged nickel alloy steels provide the strength and toughness needed in columns, cylinders, die-block holders and dies of this giant machine. Among the first of the facilities in the U. S. Air Force Heavy Press Program, this unit is a notable engineering achievement of United Engineering & Foundry Co., Pittsburgh, Pa.

Nickel alloy steels strengthen huge press for 35,000-ton squeeze

EIGHT 200,000-POUND FORGINGS of steel fortified with 2¼% nickel! That's what was specified to give this mammoth press essential strength. Used as four 2-column units, these forgings are subjected to the tremendous force of 35,000 tons.

Nickel alloy steel provides the level of strength and notch toughness required. These massive columns are each 61′ high and 34″ in diameter. Whenever a component's size restricts methods of heat-treating, or permits forging only limited portions at a time, improved strength and elastic properties depend particularly upon correct alloy content.

Nickel alloyed steels are used for still other parts that encounter high stresses and loads.

Dies and die holders gain needed stamina from additions of nickel. Among the largest steel castings ever used in press construction, the top and bottom die holders of this press are nickel-chromium-molybdenum steel approximating the 4340 composition. Each measures 26′ by 12′ by 25″ and weighs 350,000 pounds.

In many a metal, you can improve specific properties by use of nickel alone or in combination with other alloy elements. When you seek the solution to a metal problem, let us give you the benefit of our wide practical experience.

Send the details of your difficulty for our suggestions. Write us now.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

RELIABILITY

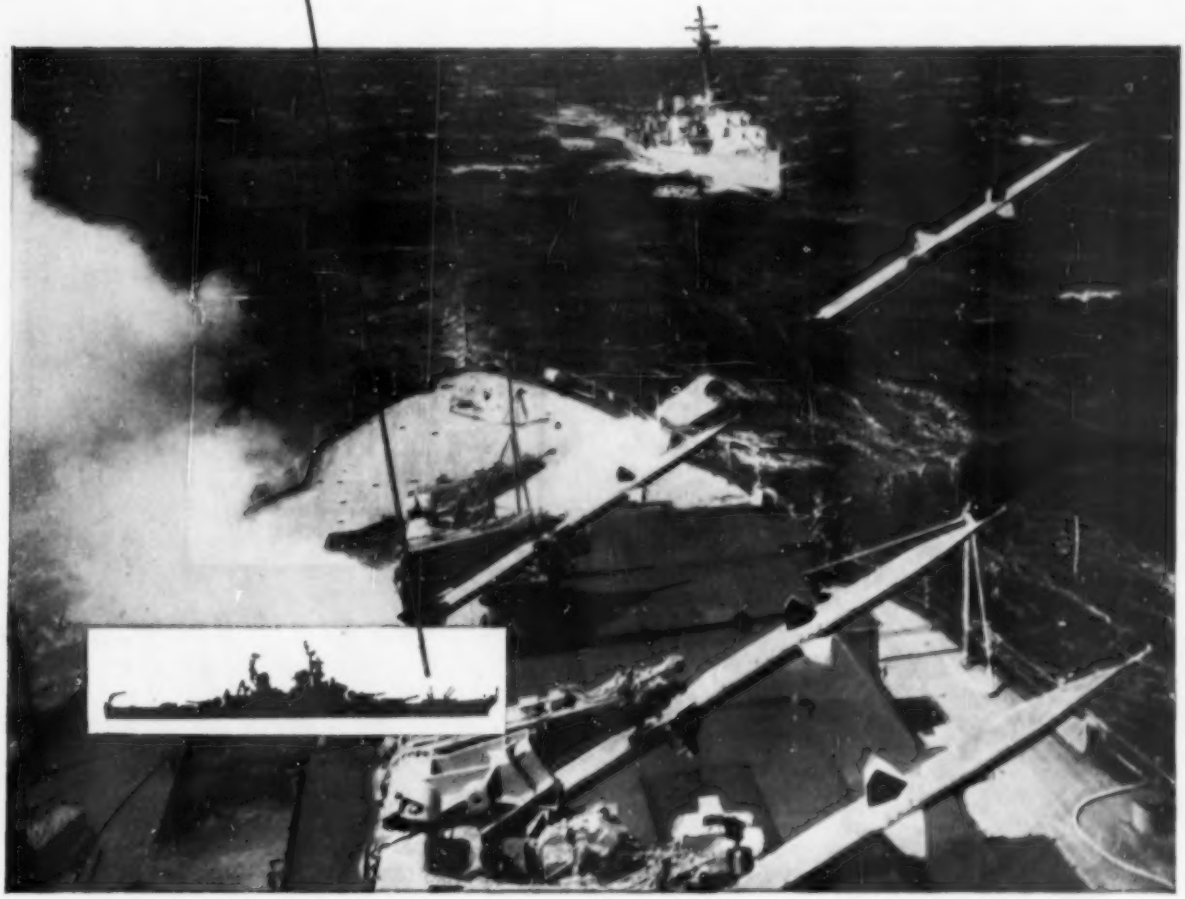
Dependable performance is a quarter-century tradition at Motorola—the world's largest exclusive manufacturer of electronic equipment. Under subcontract to Convair, Motorola *engineered for reliability*, and is now producing the guidance equipment for the Navy's new all-weather anti-aircraft missile, the "Terrier".

Positions open to qualified Engineers and Physicists

MOTOROLA

COMMUNICATIONS & ELECTRONICS DIVISION
National Defense Department

2710 N. CLYBOURN AVE. • CHICAGO, ILL. • Laboratories: Phoenix, Arizona and Riverside, California



New Alcoa V-Beam Roofing Sheet permits heavier loads on longer spans

One 18-foot sheet of Alcoa® Aluminum V-Beam can span over three roof purlins or siding girts on 8'-9" centers and will resist a 30-pound uniform load per square foot with a safety factor of 2.

The deep (1¾") corrugations of Alcoa V-Beam permit roof slopes as flat as 2 inches in 12 inches. At the same time, these deep channels provide a pleasing, modern appearance.

Alcoa flat industrial flashing sheet (0.040 inch thick) can be used in conjunction with preformed seals or closures of aluminum or rubber. Standard fasteners are available.

V-Beam rounds out the Alcoa line of aluminum building products . . . a line that more than ever meets the broad needs of the construction industry.

Light, strong, maintenance-free, Alcoa Aluminum Sheet and Fasteners are making possible new types of construction at lower-than-ever cost. You get better-looking, easier-to-erect, maintenance-free buildings. You get the advantages of aluminum's reflectivity to keep buildings 15% cooler in summer and warmer in winter.

For full information on V-Beam . . . (1) Write for the new AIA Data Sheet; (2) Ask for the names of competent nearby firms specializing in aluminum construction; (3) Call the nearest Alcoa sales office and request the help of an Alcoa architectural consultant. ALUMINUM COMPANY OF AMERICA, 850-E Alcoa Building, Pittsburgh 19, Pa.

SPECIFICATIONS

Lengths	5' to 18' in 6" increments
Sheet thickness	0.040"
Sheet width	41⅛" (approx.)
Coverage	39" (8 corrugations)
Pitch	4⅞"
Depth	1¾"
Top and bottom flats	¾"
Finish	Stucco (E-5 pattern)

★ ★ ★

MAXIMUM SAFE LOADS

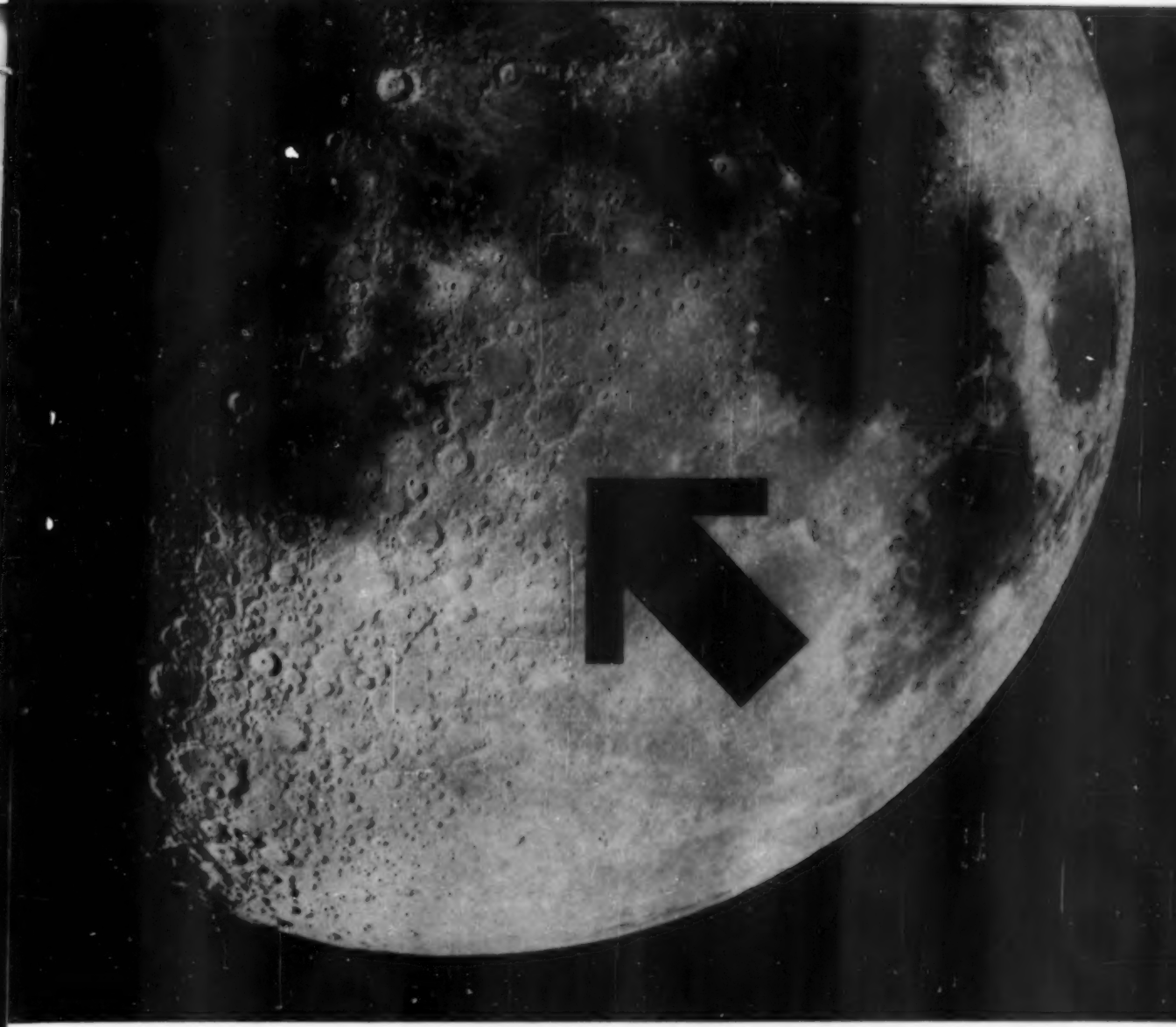
(Safety factor of 2)

Purlin or Girt Spacing	Load (lb per square foot)
10'-6"	21
10'-0"	23
9'-6"	25
9'-0"	28
8'-6"	32
8'-0"	36
7'-6"	41
7'-0"	47
6'-6"	55
6'-0"	65
5'-6"	78
5'-0"	95
4'-6"	118

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM

Join 30 million Americans in enjoyment of the ALCOA HOUR — every other Sunday on NBC-TV. Consult your newspaper for time and channel.



NEW FRONTIER

"If we had to put a man on the moon, we could do it."
—Overheard at an Institute of Aeronautical Sciences luncheon

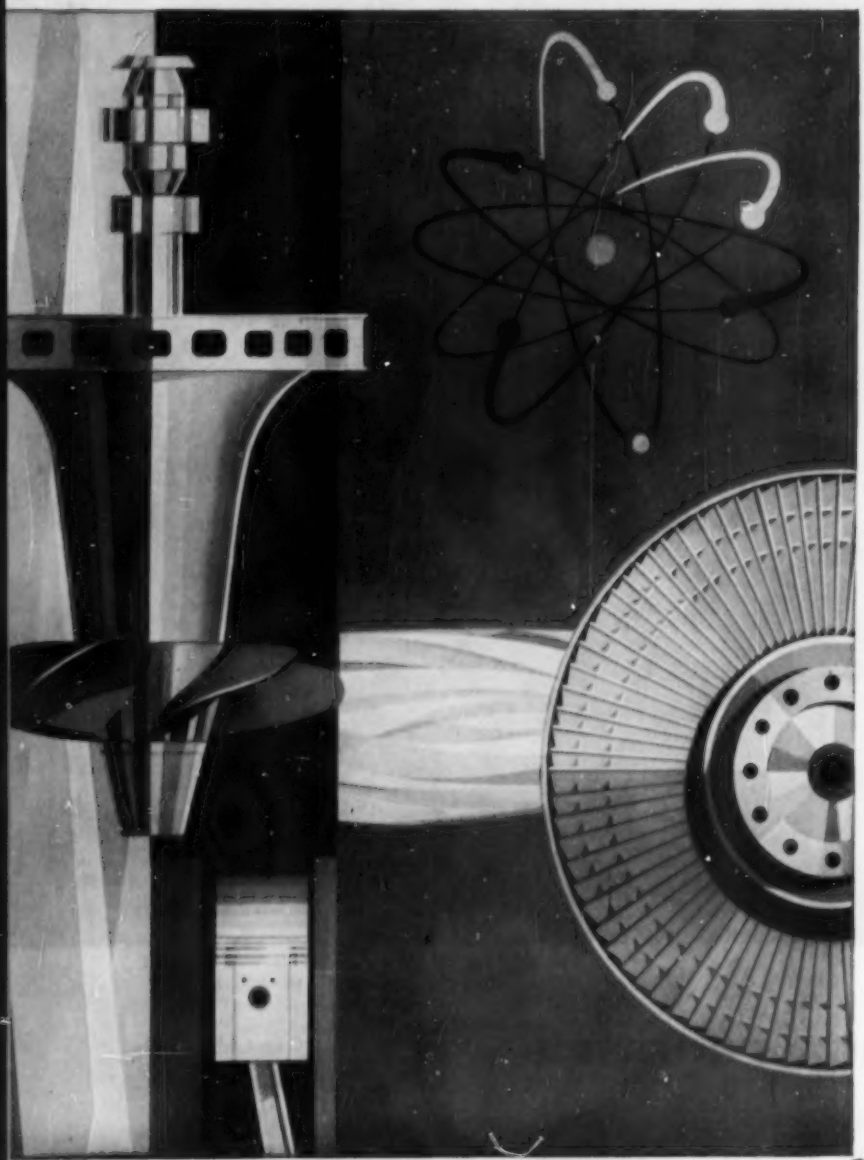
This impromptu statement was not a matter of idle conjecture. It was a statement of a positive and scientific fact – as provable as if he'd said the Aleutian Islands – and contingent only upon three prime requisites: enough time, money, and necessity. And by "we" he meant today's mindpower and facilities operating under the most advanced concepts of research and development.

Those concepts as practiced at Martin today would be essential to the fastest possible solution of any complex flight systems problem now within the capacity of man to solve.

It is this that has established Martin as one of the prime forces in the coming conquest of the new frontier – Space itself.

MARTIN
BALTIMORE

Symbols of Progress



These major forms of power are the building blocks of progress. Power from rushing water, put to work by hydroelectric plants . . . from superheated steam, spinning thousands of turbine blades . . . from petroleum, through internal combustion engines . . . and now from the atom itself.

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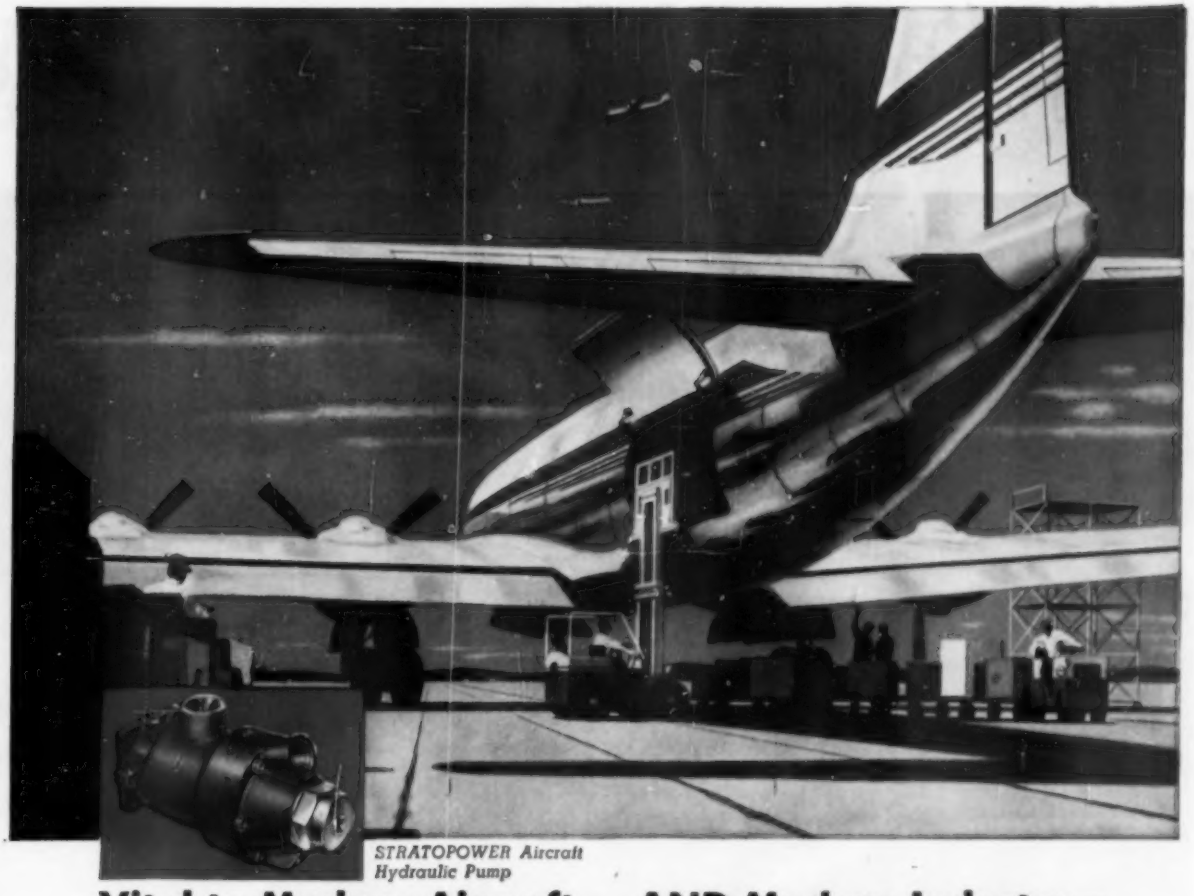

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Vital to Modern Aircraft... AND Modern Industry— FLUID POWER

Forces are so great and response requirements so exacting at today's air speeds that no man is strong enough or quick enough to adjust controls for even the simplest maneuver. Yet, a STRATOPOWER Hydraulic Pump, smaller than a football, provides Fluid Power that enables a pilot, with no more than a "fingertip flip," to perform, precisely and instantly, a dozen jobs. Among these are: raising and lowering landing gear, operating control surfaces or wing flaps. And, STRATOPOWER Pumps with their amazing weight/horsepower ratio perform many other supplementary chores in the air such as: powering air conditioning and pressurizing equipment, radar scanners and other jobs that Fluid Power does better.

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In addition to two Divisions specializing in Power Hydraulics, there is valuable "know-how" in Liquid Handling at Aurora Pump and Kinney Mfg. Divisions plus intimate knowledge of Vacuum Processing in the Kinney Mfg. Division.

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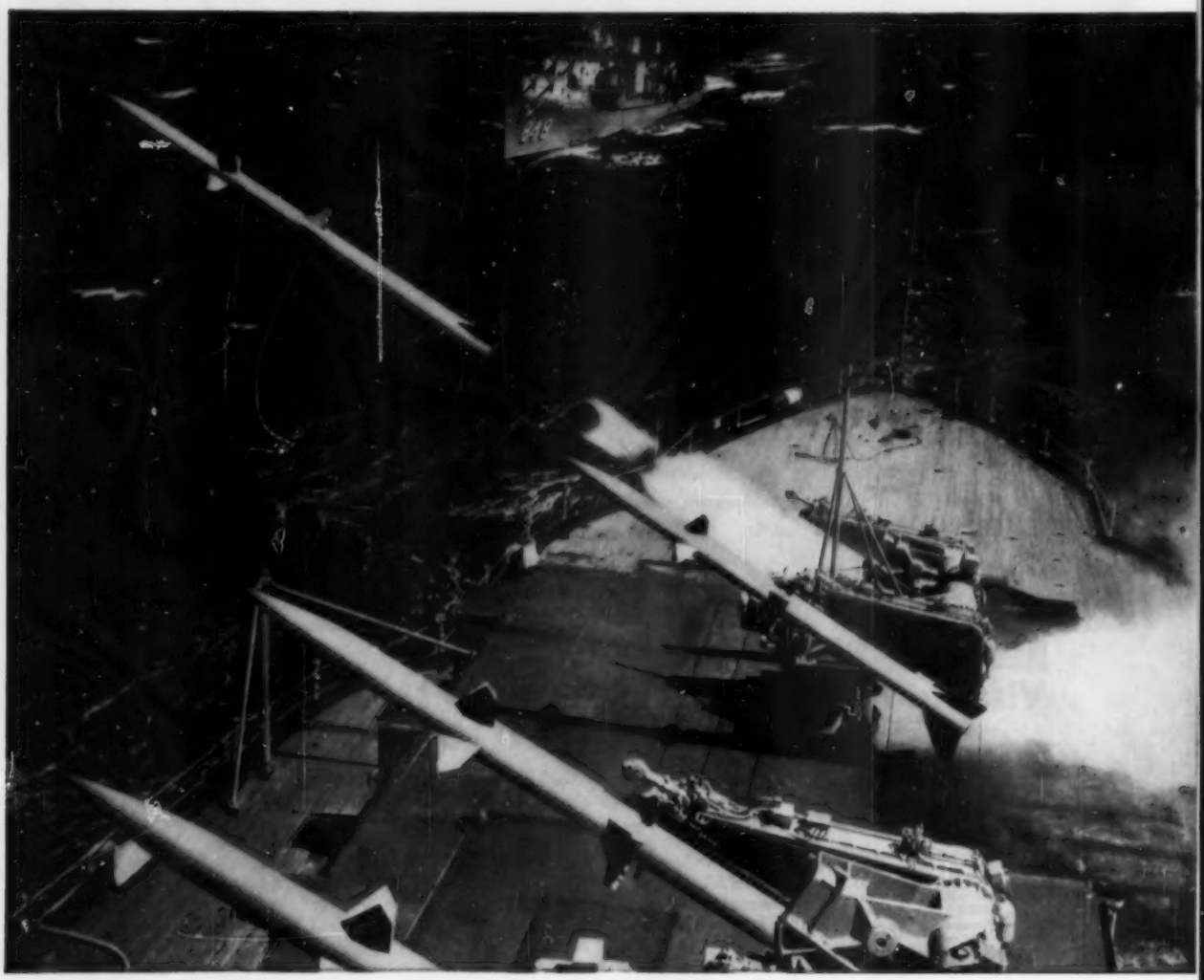
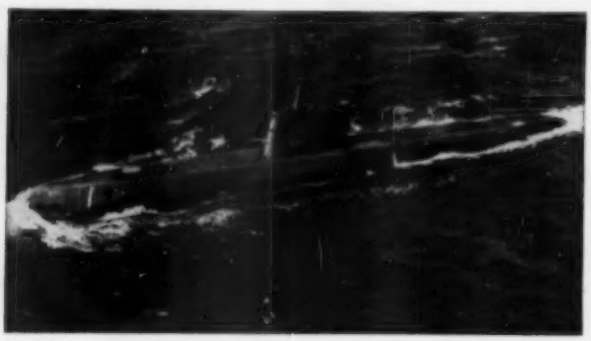
ALCO *supplies*



CURRENT PRIME CONTRACTOR FOR ARMY'S M48A2 TANK, ALCO calls on products of some 1500 subcontractors for assembly. M48's will be built in facilities which produced thousands of M47's during Korea, will receive benefit of know-how drawn from almost 10,000 ALCO-built tank vehicles.

HEAT EXCHANGERS FOR ATOMIC SUBMARINE were built by ALCO. The Nautilus has radical-design ALCO exchangers in its reactor system. Design, to solve advanced heat-transfer problems, and facilities for difficult manufacture were provided by ALCO.



s key items for defense

Important Components from ALCO are Installed in Leading Weapons of All Three Services; ALCO also Serves as Prime Contractor

ALCO-built weapons components range from heavy final drives for tanks to air flasks and propellant chambers for missiles, to complicated and precise recoil mechanisms. For the M48A2 medium tank, ALCO also serves as prime contractor, doing complete assembly of items from 1500 suppliers.

Long experience in defense production, beginning in 1860, is one reason why ALCO is successful in helping make modern weapons. Its products have included guns, shell casings, locomotives and marine diesels, among others. During World War II and Korea, ALCO made thousands of combat tanks.

Production and design facilities are another important reason for ALCO leadership. Its plants are equipped to assemble heavy defense items in large quantities, and also to produce highly complicated components for other prime contractors. ALCO's design engineering staff is expert in specialized fields such as atomics and weapons development.

ALCO production available for defense purposes includes heavy weldments, heat-transfer items, pressure containers and vessels, springs, forgings, rings, precision-machined items, diesel and atomic power, and all types of assembly, including electronics.

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ALCO

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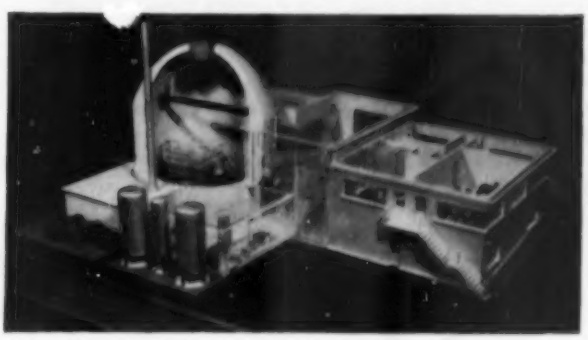
NEW YORK

RECOIL MECHANISM FOR ARMY'S 155 MM HOWITZER, a precision-manufactured complex of springs and hydraulic units, was manufactured by ALCO as prime contractor. Army Ordnance called ALCO production of this item "in the highest quality group received from industry."

ARMY PACKAGE POWER REACTOR, not a weapon, will generate power at Fort Belvoir, Va. Future APPR's will power remote installations. ALCO holds prime contract for unit, won in competition with 17 top U. S. manufacturers. APPR will be erected by ALCO by early 1957.



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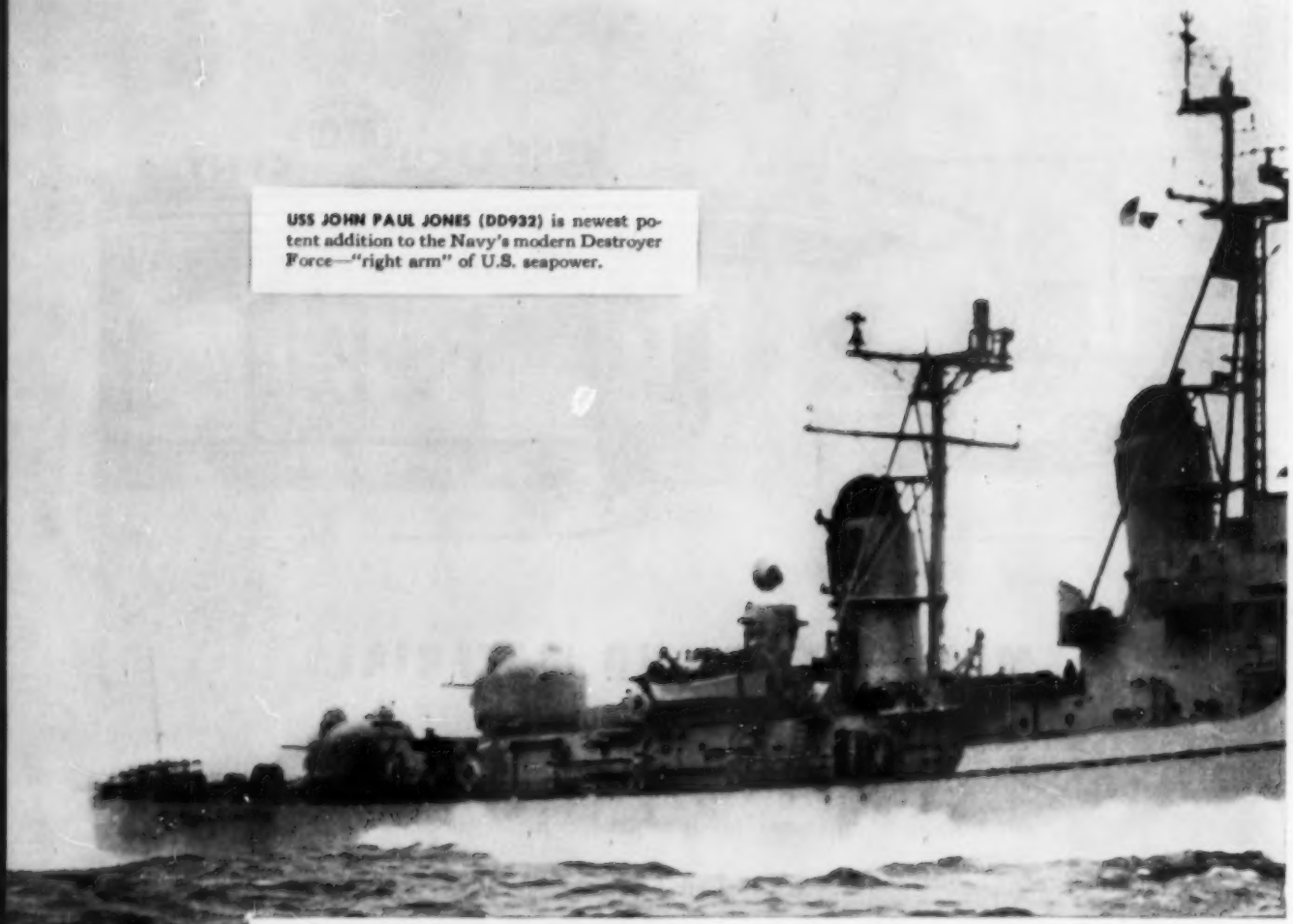

USS JOHN PAUL JONES (DD932) is newest potent addition to the Navy's modern Destroyer Force—"right arm" of U.S. seapower.

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General Electric ordnance equipment has been selected to assist the USS John Paul Jones in the defense of American shores. DD932 is the Navy's newest addition to its Destroyer Force.

G.E.'s famous Mark 56 gun fire control system and rugged power drives protect the USS John Paul Jones fore and aft against air attack, while G-E controls help speed acquisition of surface targets. Below decks, G-E fire control switchboards co-ordinate all topside batteries. Target designation and underwater battery switchboards complete General Electric's ordnance contribution to the USS John Paul Jones.

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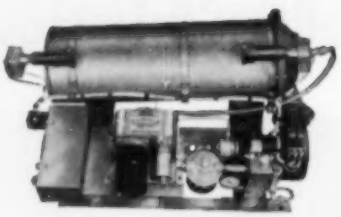

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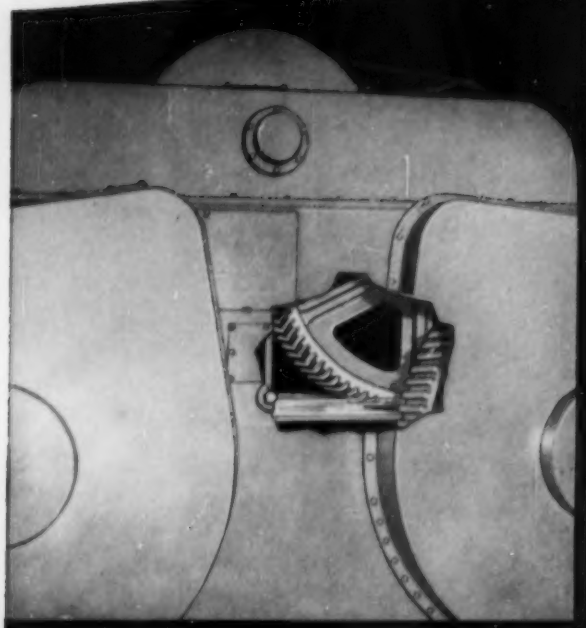

Cutaway showing how herringbone intermediate gears operate in oil bath within the crown.

Cutaway showing Verson main gears and the oil bath in which they operate.

As the cutaway views at the left show, drive gears in Verson presses are fully enclosed and operate in an oil bath.

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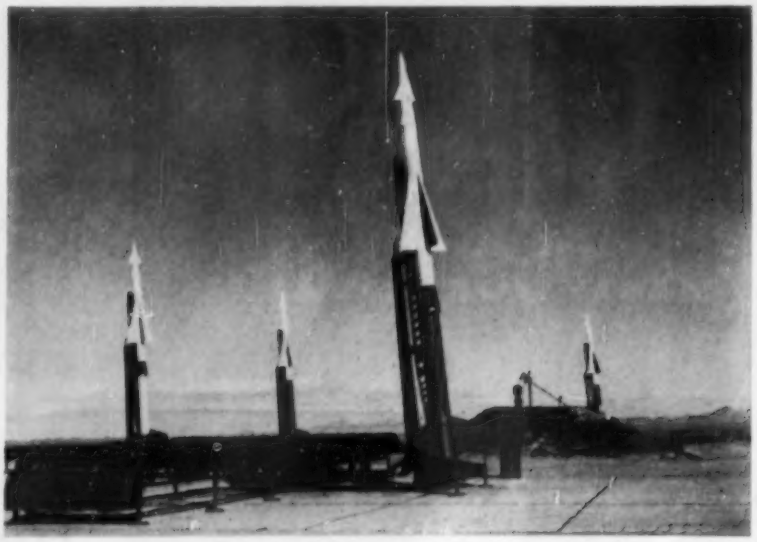

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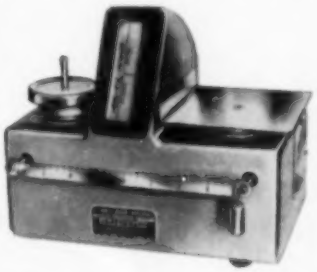

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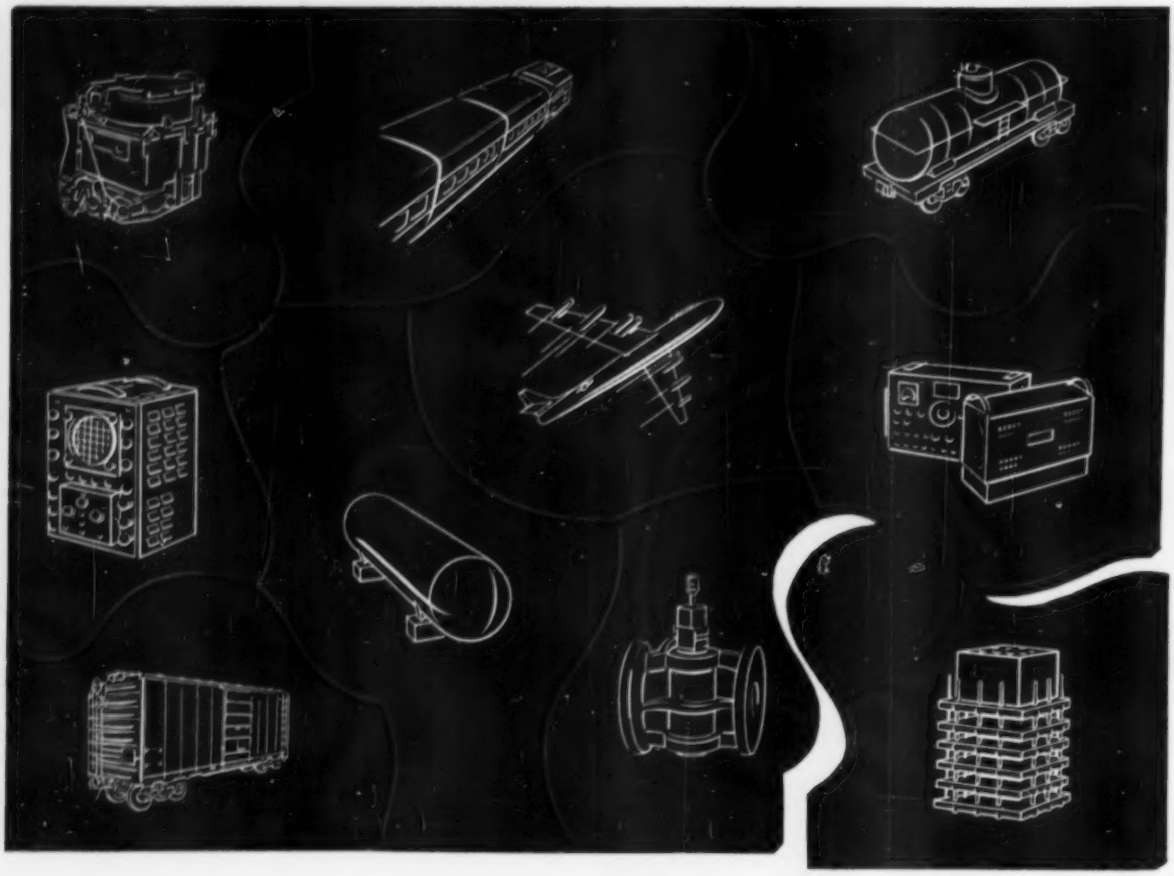

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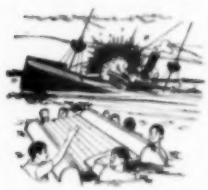
"¡Valiente!" cried the Spanish admiral

He cheered as his launch fished this man and seven more waterlogged American sailors out of Santiago Harbor, Cuba, on the morning of June 4, 1898. This was straining Spanish chivalry to the breaking point, for Richmond Hobson (right) and his little suicide crew had spent the previous night taking a ship into the harbor entrance under a hail of cannonade and deliberately sinking her to bottle up the Spanish fleet.



Hobson, who planned and supervised every detail of the operation, from placing the scuttling charges to dropping anchor under fire, was actually an engineer, not a line officer.

In Santiago Harbor, he led his first and only action against the enemy. But his cool-headed daring made him as much a hero of the day as Admiral Dewey. And proved again that America's most valuable product is Americans.

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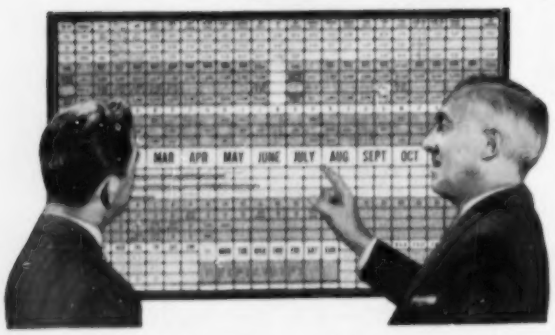

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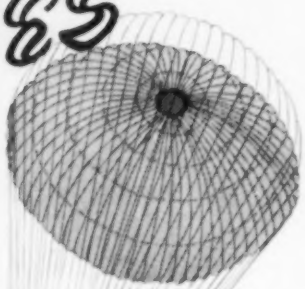

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INDEX TO ORDNANCE

VOLUME XL

● The Index to Volume XL of ORDNANCE, with title page for binding, will be available shortly. It will be sent free of charge upon request to the Editorial Offices at the address below.

● It covers subjects in the following 1955 and 1956 issues: July-August (No. 211); September-October (No. 212); November-December (No. 213); January-February (No. 214); March-April (No. 215); and May-June (No. 216). It is arranged alphabetically by subject and author.

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains selected papers presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture and field use

Underwater Missiles

The modern torpedo is a complex weapon that requires precise gaging

E. J. Krueger

Technical Director, Gage Laboratory, U. S. Naval Ordnance Plant, Forest Park, Ill.

HISTORICALLY, the torpedo is a weapon with whiskers compared with the other matériel used in modern warfare. Prior to the nineteenth century the term "torpedo" had been employed to describe any explosive charge, complete with a detonating feature, prepared in advance and transported to the site of intended use where it might be hidden, either under water or on land, thrown, or otherwise propelled to explode on contact with a solid object.

Currently, a torpedo may be defined as a small crewless underwater craft, self-propelled and self-steered, either laterally or for depth, transporting an explosive charge arranged to detonate on contact with or in proper proximity to its target. It may be tube-fired from a submarine, deck-fired from a warship, or launched from an aircraft.

THE torpedo in its infancy consisted of many types of applications of explosives. The earliest known application to marine warfare occurred in 1585. Ferderigo Gianibelli came to the assistance of the city of Antwerp which was besieged by the Spaniards. A fortified bridge had been built across the Scheldt to prevent the Dutch from running supplies into the city. The artful Giannibelli filled a small ship with gunpowder and set it adrift. The current carried the craft against the bridge where a clockwork fuze exploded it, blowing up half the bridge and a thousand Spaniards.

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The American Civil War brought out a rash of experiments in submarine and torpedo warfare. Raines of the Confederate forces developed a guided missile which in reality was a sausage-shaped iron craft christened "David" (after Goliath's antagonist) armed with a spar torpedo projecting from the bow on a long pole. With this weapon the Confederates stalked the NEW IRONSIDES one dark night, pulled the lanyard, and dealt the ship a blow that sent her to the yards for repairs.

IN 1864, Messrs. Willoughby and Ramsey demonstrated a new torpedo in the Potomac River off Washington, D. C. This weapon was a small launch powered by a petroleum-fired steam boiler and capable of an average speed of four knots. It dragged two tiller lines behind, the lines paying out from two drums on the shore. The application of a brake to either of these drums placed more pull on one tiller line than the other and thus steered the launch much as a plow horse is guided.

The inventor of this device in his

claims to Congress stated that: (1) With ten such launches, aided by the blockading fleet, it would be possible to clear the harbor of Charleston, S. C., of all obstacles; (2) With two or three clipper-built merchant ships, each carrying two or three such launches, we could clear the seas of all Confederate privateers; (3) With two hundred of the launches, we could defend the port of New York against the combined navies of the world.

However, the pattern of the Civil War was established by this time with the "power plays" of Grant and Sherman, and this development was aborted.

ALTHOUGH the Americans were making great progress in torpedo development, the big step was evolved in Austria by an army officer and exploited by an English company. Robert Whitehead, the Englishman, built as his first effort a cigar-shaped vessel of steel approximately eleven feet long and fourteen inches in diameter. The motive power was derived from the energy stored in compressed air at a pressure of 700 pounds per square inch. The explosive charge consisted of eighteen pounds of dynamite carried in the warhead which was secured to the forward end of the air flask. The motive power and controlling mechanisms were contained in the afterbody. The torpedo was propelled by a 40-horsepower "Brotherhood" engine driving a single propeller which projected the weapon at a speed of 6 knots for a range of 600 feet.

In the period of early production of the Whitehead torpedo, the details of this invention were guarded with great secrecy. It was kept secret largely due to commercial considerations, although units could be purchased for a specified sum of money by any nation desiring to obtain them. European nations were quick to grasp the opportunity to equip their navies with the Whitehead torpedo since at that time they were considered absolutely supreme as engines of naval warfare.

IN 1896 the United States purchased torpedoes from the Whitehead Company in England. Shortly after the acquisition of these torpedoes the device was greatly enhanced in value as a weapon of precision by the introduction of gyroscopic control of the vertical rudders which in turn controlled the course of the torpedo.

SOON after this development the E. W. Bliss Company of Brooklyn, N. Y., purchased the right to manufacture Whitehead torpedoes in the United States. Through the application of some exceptionally skilled engineers and with the coöperation of the Government's torpedo facilities, a new torpedo was developed possessing many improvements in mechanical detail and broader applications of sound engineering principles. The new design divorced the United States from the dependency upon the common torpedo of other nations and provided a weapon superior in performance to any in the world at that time.

The next important step in torpedo power plant development came when the Bliss-Leavitt combination produced a torpedo in which a turbine was used in place of the reciprocating engine. The advantages of the turbine over the reciprocating engine were so impressive at the time that the change was readily made by the Navy Bureau of Ordnance. Thus the power plant of the United States torpedo became the gas turbine in which the chemical energy in the combustion pot was delivered as heat to the working fluid. The energy in the gaseous products was converted by the turbine and transmitted through gearing to the propellers.

In World War II the principal torpedo was a steam-turbine-driven weapon. During the war, torpedo development brought about new changes to underwater warfare such as long-range wakeless electric propulsion, proximity detonation, and improvement in explosives. Today the torpedo may be likened to or compared to the guided missile. Torpedoes are classified as underwater-to-underwater, underwater-to-surface, surface-to-underwater, and air-to-underwater weapons. The prime difference between guided missiles and torpedoes is the medium through which they navigate.

The torpedo is a curious blend of mechanical, pneumatic, hydraulic, electrical, and electronic features. These features are embodied in (1) the framework which must be constructed to withstand impact from air drop as well as pressures exerted by several hundred feet of water; (2) the guidance and control system which, like in the guided missile, must guide the weapon over a predicted path and correct when necessary the deviations in its route to eventual destruction; (3) the power plant which must be capable of delivering a propelling force to carry the weapon at high speed in all weather; and (4) the warhead and fuze which are in effect the payload of the weapon and must be capable of delivering a devastating blow to an enemy vessel, large or small.

THIS, then, is the weapon to which the Gage Laboratory at the Naval Ordnance Plant at Forest Park, Ill., has dedicated its efforts.

Turning now to the production of the weapon, it is readily understood that the quantity of torpedoes produced is low when compared with guns, projectiles, or rockets. Further, the weapon may be fired and retrieved many times before it is overhauled or discarded. Thus just prior to World War II, facilities for production of the torpedo were vested in a very few organizations.

Through the war, manufacture of the torpedo was vested in several companies with subassemblies and component parts being subcontracted to organizations across the country. Each contractor, along with the Navy inspector, tried to ensure quality of product, but with a complex weapon many differences of opinion occurred, and interchangeability and function of parts and subassemblies was not achieved to the fullest extent possible.

CREATION of the Gage Laboratory at Forest Park shortly after World War II introduced the standardization of inspection equipment and gages to the torpedo-building program. The Gage Laboratory reviewed the various weapons being produced, developed inspection plans, and provided the hardware required to ensure safety, life,

This article is based on an address given by Mr. Krueger at the eleventh annual meeting of the Dimensional Standards and Metrology Division of the American Ordnance Association held at Watervliet Arsenal, Watervliet, N. Y., January 26, 1956.

interchangeability, and function. When the quality-control program got under way, coördination with the Ordnance Classification of Defects was established, making uniform inspection of torpedo ordnance mandatory.

The Bureau of Ordnance currently has several complex weapons in its defense program. These weapons have been developed by naval engineers and by private enterprise. Attendant to the production and testing of such weapons there is continuing need for spare parts, increased shelf life, improvement in operation, and improvement of the product.

THE Gage Laboratory currently plays an important part in the development and production of these weapons. Getting into a program at an early stage allows the gage engineer to study the component subassemblies and assemblies and detect flaws or errors in the product design. Being familiar with preceding weapons and weapons still in production, the gage engineer is also effective in establishing standardization in and between weapons.

Gaging a torpedo is generally divided into two parts—electrical and mechanical. It should be appreciated that the electrical circuitry of a torpedo is a complex electronic system that uses the input data obtained to correct the course of the torpedo to the objective.

While the Research and Development Branch of the Navy Bureau of Ordnance provides test gear to check out a torpedo, it falls to the Gage Laboratory to make sure that this test gear operates precisely as intended. The Gage Laboratory thus provides precision checking instruments, precision power supplies, and, in some instances, electrical gages or instruments to inspect the subassemblies or components.

The backbone of the electronic inspection service provided by the Gage Laboratory at Forest Park is the standards system. It in many ways parallels the mechanical standards system which involves the primary standards maintained at the National Bureau of Standards.

THE Gage Laboratory intercompares secondary standards with primary standards at the Bureau of Standards and, having these available, sets working standards which are in turn furnished to the Navy inspector who in turn checks out test sets and workshop equipment at the source of torpedo manufacture, loading stations, or at repair depots.

"In World War II the principal torpedo was a steam-turbine-driven weapon. During the war, torpedo development brought about new changes to underwater warfare such as long-range wakeless propulsion, proximity detonation, and improvement in explosives.

"Today the torpedo may be likened to or compared with the guided missile. Torpedoes are classified as underwater-to-underwater, underwater-to-surface, surface-to-underwater, and air-to-underwater weapons. The prime difference between guided missiles and torpedoes is the medium through which they navigate."

Electrical quantities evaluated by Gage Laboratory equipment include voltage, current, revolutions per minute, frequency, time, resistance, reactance, impedance, phase, or various combinations of these. Field instruments provided by the Gage Laboratory for the measurement of frequency or time have an accuracy of one part in one hundred thousand. Gages of this type are intercompared at the laboratory against standards accurate to one part in several million. Electronic gages which measure values which do not contain the factor of time are accurate to about one part in one thousand and are in turn calibrated against standards which are ten to fifty times more accurate.

Turning now to the mechanical phase of gaging, the Gage Laboratory follows the broad principles outlined in Bureau of Ordnance Standard 66.

IN its early infancy the Gage Laboratory provided the inspector with an inspection plan and then provided the gages to make that plan function. With the adoption of a more scientific approach through quality control, a working agreement with the Quality Control Division at the Central Torpedo Office in Newport, R. I., was reached, and the two organizations dovetailed their efforts to provide a more effective inspection program. Thus, using the Ordnance Classification of Defects as a guide, the gage engineer now devotes his attention to the most effective method of gaging the ordnance material to be produced.

The torpedo, as I have mentioned before, is a complex mechanism which is further complicated by the requirement that its component parts and assemblies must be enveloped in the long thin case with which we are all familiar. Further stumbling blocks to an easy program of gage supply are the quantities of weapons or lot sizes which are produced.

We in the Navy gage programs are as cost-conscious as any private concern, but on the limited budget for gages, which is extracted from the funds allowed to produce the weapons, magic must indeed be performed. So when the military standards for gages were published, the Navy gage laboratories jumped in with both feet and employed these standards to the fullest possible extent.

WITH the resulting savings from this standardization and with the attendant reduction of paper shuffling, time is being spent more effectively in developing gages for the more complex items in torpedo manufacture.

Presently the Gage Laboratory, while providing the inspection gages for the several torpedoes in current production, is also employed in developing (1) a machine for the inspection analysis of torpedo propulsion propellers which vary in size, number of blades, cross section, pitch, and other characteristics; (2) a machine to analyze the various characteristics imposed on the turbine wheels and buckets of the steam-driven torpedoes; and (3) ways and means to provide economical, effective inspection equipment to meet the challenge of ever-decreasing tolerances imposed by the product designer on modern Navy ordnance.

The Gage Laboratory in achieving the progress it has attained in its several years of existence has had two substantial assistants. I should give credit where credit is due, first, to defense organizations upon whose experience the Gage Laboratory has drawn, and, secondly, to the ever-present helping hand of private industry, especially the private gage concerns.

New Shell Forging Method

Hot heat-treat procedure eliminates handling forgings and reheating for quenching and makes possible continuous automation from billet to the completely heat-treated and nosed high-explosive projectile

W. N. Howley, Jr.

IN this era of revolutionary changes in manufacturing methods the necessity of accurately appraising the relative worth of different processes becomes apparent.

A realization of certain basic principles prompted our company, with the coöperation of the Navy Bureau of Ordnance, to develop a new and improved method of hot forging shells. To appraise this or any method of manufacture, it is necessary to segregate the factors which influence the cost of the finished piece—then eliminate those which can distort an appraisal.

The selling price of any product is made up of a number of elements, many of which have no relation to the method of manufacture. Therefore, a comparison of methods which uses selling price as its basis is basically unsound.

Since total manufacturing cost is influenced as much by production rates, assurances of steady work, plant layout, efficiency of supervision, etc., as it is by the method of manufacture, it too is a poor basis to use in comparing methods.

SINCE neither selling price nor total manufacturing cost can be used reliably to appraise or compare methods, we have made our comparisons using only those costs which are directly related to the manufacturing process.

In conventional high-explosive shells of 75 mm. and larger, there is a certain portion of these related costs which should, in a comparison, be considered as constant regardless of the method of forming. The costs of these operations and the materials required for them are determined by specification and must therefore be performed. These operations include a majority of the finishing and inspection operations and represent approximately one-third of the total costs to be considered.

Mr. Howley is assistant to the president, Lansdowne Steel & Iron Company, Morton, Pa. Mr. Howley delivered this paper at a meeting of the Shell Committee of the A.O.A. Bomb and Artillery Ammunition Division.

ALTHOUGH this is an approximate percentage, it is a composite of years of experience on innumerable sizes and designs of shells at our Morton, Pa., plant and the plant our company built and operated for the Ordnance Department at Gadsden, Ala.

The remaining elements of cost in the manufacture of a high-explosive shell by the hot-forging method may be categorized into three basic groups: (1) The cost of forging and turning tools; (2) The operational costs for forging, turning, heat-treating, and blasting; (3) The cost of steel.

Let us examine these three categories more closely. Forging and turning tools represent approximately seven per cent of the total considered costs. An investigation at Gadsden, continued at Morton, reveals that the piercing tools for forging and the rough-turning tools make the bulk of this cost. Neither of these operations can be eliminated by any hot-piercing method.

Our estimates of the total tooling cost revealed that there would be little if any difference in tool costs whether the pierced cup was drawn hot or cold.

In our development of a new method of hot forging, we, however, took into consideration that an increase in piercing tool life is directly related to a decrease in piercing temperature (within certain ranges). We, therefore, have reduced the piercing temperature from 2,200-2,300 degrees to 1,800-1,900 degrees and have accomplished a marked improvement in piercing tool life of approximately 30 per cent.

THE cost of rough-turning tools is dependent upon four basic factors: the variation in hardness from forging to forging, the surface scale on the forging, the machinability of the steel, and the eccentricity of the forging (assuming finish allowance is not excessive).

In our new method we have improved or eliminated the first three of these factors by delivering to the rough-turner a clean, heat-treated forging and have reduced the fourth by closer control of our piercing operation. As a result of these improvements and the use

of carbides designed particularly for this operation tool costs are being appreciably reduced.

The conventional hot-forging method is made up of a number of discontinuous operations, such as forging, heat-treating, rough-turning, etc., which cannot readily be tied together into one continuous series of operations.

> *"The cost of rough-turning tools is dependent upon the variation in hardness from forging to forging, the surface scale, the machinability of the steel, and the eccentricity of the forging."*

THE process materials (coatings, lubricants, etc.) are rather small items in hot-forging. However, in cold-forming they become quite sizable items of cost.

The cost of heating in the conventional hot-forging method, although it requires a complete reheating for quenching, is less than, or at most equal to, the heating costs in any cold or hot-cold method of manufacture.

In the development of our new method we took into consideration all these cost factors and as a result have: (1) Eliminated the problem of handling or disposing of hot forgings; (2) Eliminated completely the necessity of reheating for quenching; (3) Established a method which is particularly adaptable to continuous automation from the billet to the completely heat-treated and nosed shell; (4) Made it possible to check physicals in the shell for acceptance or rejection within an hour after delivery to the forging furnace.

These savings will reduce this category of cost by approximately 40 per cent.

IN addition, this method is not dependent upon an uninterrupted sequence of operations and, therefore, if desired, heat-treated and nosed shells can be shipped to diverse finishing plants throughout the country, not too much unlike the spreading of automobile assembly plants.

The responsibility of forging, heat-treating, and forming can be, if deemed desirable or necessary, vested in those companies experienced in these arts, and the final machiner need not be concerned with these problems. With such forge shops located near steel-producing plants, great savings could be realized in freight on billets and scrap.

In addition to these advantages, we are currently, together with one of the leading machine-tool manufacturers, experimenting with unbelievably high turning speeds. The machines are being built at the present time and will be installed in our plant for perfection before being released for large production. The possibilities of savings are remarkable.

Steel alone represents approximately 50 per cent of the considered costs. There are accurate definitions for steel mill products and their qualities. These have been determined over a number of years by establishing the basis for acceptance and rejection of the different grades and qualities. Otherwise it would have been impossible for manufacturers of finished products to determine what grade and quality he would equip his plant to handle.

IT might make the picture a little clearer and not so controversial if we identify a group of steel qualities by numbers instead of name.

Quality No. 1.—This is sometimes defined as rerolling or merchant quality. It has not been considered satisfactory for products such as shells by either experienced shell producers or steel makers and therefore needs no additional consideration.

Quality No. 2.—This is satisfactory for hot-forged shells with proper equipment at the forge plant. It is sometimes single- and sometimes double-converted. Visual inspection of the surface is satisfactory. Wide ranges of chemistry are perfectly satisfactory since physical properties are obtained by quench and draw heat-treatment.

Quality No. 3.—This steel has a special classification but has never been definitely defined as to quality nor how it differs for acceptance and rejection from No. 2.

THE following qualities, No. 4 and No. 5, necessitate closely controlled steel-making practice, starting with control of raw materials, inspection, and the need for the steelmaker to produce steel within more restricted chemical limits if physical properties must be obtained by cold-working elements in the steel.

Quality No. 4.—This is called hot-cup cold extruded quality predicated on adequate machining of the hot-cup prior to cold extrusion.

Quality No. 5.—This has the requirements of No. 4 and in addition is not predicated on adequate machining of the outside. To date this is awaiting a definite quality classification by the steel producers.

Some years ago it was necessary for us to approximate the spread between the cost of hot-forging and cold-working steels. At that time we determined that the steel which was the least restrictive, most ideally suited to the basic open-hearth or electric melting practice and produced the most desirable billet surface was that required by the hot-forging—Steel No. 2.

SINCE this method has, as an integral of its operations, the peeling of the surface and obtains physical properties through reliable methods of heat-treating, it allows the use of the widest range of chemical elements and does not place additional conditioning burdens on the mill.

We have consistently stated that the use of cold forming steels, where additional burdens are thrown on the producing steel mills, would eventually cause a big spread between their costs and the cost of hot-forging steels.

The spread which we estimated and estimates within the steel industry very closely approximate the prices which have been published by the steel industry in the last few months and show that for one pound of No. 4 billet steel you can use up to 1.4 pounds of No. 2 billet steel.

As we improved, eliminated, and changed operations we kept foremost in our minds that any new methods must be capable of using simple, readily available steels since in time of emergency the shell program places tremendous requirements on the steel industry.

For us it has been a long and, of necessity, slow journey. However, we have developed, for conventional high-explosive shells, a new method which uses steel recommended for years by the steel-making industry as readily available. By the use of these steels, production of quantities of finished shells at a low cost can be assured.

Early American Artillery

Field guns had an important part in winning the Revolutionary War

Jac Weller

WE forget sometimes that our nation was born in war—the longest and in many ways the hardest that we ever fought. In the eight years, seven months, and six days between the battles of Lexington and Concord and the final British evacuation of New York our forces changed from an indifferently armed rustic militia to a national army with a distinctive ordnance.

In the Revolution we overcame superbly armed and equipped bodies of professional soldiers. We won our independence by force of arms. The artillery, small arms, and auxiliary ordnance that we used are fascinating.

In 1775 we were, save for a small and violent minority, loyal to the British Crown. The American Colonies had differences of opinion with the ministry in power; however, we were essentially British in our ways of life and thought. Our military, sporting, and personal arms were completely British save for one notable exception —the American rifle.

*Mr. Weller is a recognized authority on American ordnance of the Colonial and Civil War periods. In a previous article, "Colonial Weapons" (*ORDNANCE, *May-June 1955), he discussed early American small arms. Mr. Weller here completes the picture with a discussion of Revolutionary artillery weapons.*

But, during the long war our weapons, largely because of aid from France, changed radically; we emerged from the conflict with an ordnance neither British nor French, but uniquely American.

In Colonial times there were many pieces of artillery throughout the Colonies; however, they were mainly for coast defense or for use within fortifications. Every port of any importance up and down the Atlantic seaboard had a few guns, usually obsolete and sometimes honeycombed with rust. In the fighting against the French and Indians on land, artillery had played little or no part as its transportation through the wilderness was next to impossible. A contributing factor to the Braddock fiasco was his insistence upon taking through the wilderness fairly heavy fieldpieces including 12-pounder guns (pictured above) which required a road. Wolfe won the brilliant Battle of the Plains of Abraham outside Quebec in 1759 with the aid of but a single fieldpiece.

However, with the coming of the Revolution, both sides relied strongly on artillery. British Ordnance had been improved and standardized by John Muller, head of the Arsenal at Woolwich, a few years before.

In the Colonies, some young men had done a tremendous amount of military reading; older men had actually seen service in European-type wars. These men realized the importance of guns, especially with raw and semitrained troops. Henry Knox, our first Chief of Artillery and later Secretary of War, did much to teach the new Army to handle its guns. He was a confirmed exponent of the British system, though much of his matériel was French.

THE efficiency of American artillery fire, which has come to be known throughout the world as one of our outstanding military qualities, dates from this time.

Whereas many pieces of large ordnance were in place at various seacoast points in the Colonies, our first train of siege artillery was brought to General Washington at Boston by young Colonel Knox from recently captured Fort Ticonderoga in the winter of 1775-1776. These guns, emplaced on Dorchester Heights and Nook's Hill early in March of 1776, forced the British evacuation of Boston with little bloodshed.

Actually, the heavy artillery did most of the fighting in the later stages of the Boston operations. Bunker Hill gave the British commanders a healthy respect for Continental soldiers behind earthworks which they never lost throughout the war.

The inventory of the weapons transported on sleds behind ox teams driven by civilians gives a good indication of heavy or siege weapons of the Revolution. Probably only a few of them were of the latest Muller type. Both brass and iron pieces were included; 12-pounders, 18-pounders, and 24-pounders were dragged on sleds over the frozen ground. A few mortars and one heavy howitzer were brought along also.

Brass at that time was a composition of about ninety per cent copper and ten per cent tin and would be known as bronze today. Copper and zinc alloys were then known as cheap brass and were inferior in strength and hardness to gunmetal brass.

ARTILLERY guns by definition were then, as today, relatively high velocity, low-elevation weapons. Even the new pieces designed by Muller still retained some irregularities and excrescences of exterior design, although he realized the futility of these. A gun generally weighed from 150 to more than 200 times the weight of the projectile for which it was designed. It had a muzzle velocity of from 900 to 1,300 feet a second and a maximum, rather inaccurate range, depending on size, of from about 1,200 to well over 2,000 yards. The greatest really effective ranges, however, were under 1,000 yards.

Even bigger guns than any brought through the frozen Green Mountains by Knox were sometimes used, especially by the British. They took 32-pounders from the main batteries of their ships of the line to subdue Fort Mifflin, on an island in the Delaware, and to open the river as far as Philadelphia. However, the 18-pounders were the most popular large pieces.

EXTANT artillery lists for the fortifications at West Point, the siege trains at Yorktown, and captured fortified positions indicate that the 24-pounder was never numerous. An 18-pounder gun (what would now be called the tube) weighed about two tons. This weapon with its carriage was about as heavy as could be transported and handled in action.

The extra power of the heavier pieces apparently did not compensate for their disadvantages. There were only a few 24-pounders and 32-pounders in the hands of the Continental artillery; however, they didn't use all they had.

Howitzers were then, as today, lighter in proportion to their projectiles, used a smaller powder charge, and had a lower muzzle velocity. They were then chambered weapons; *i.e.*, they had the powder charge in a portion of the inside of the barrel smaller in diameter than the bore proper. Garrison and siege howitzers of about 6-inch, 8-inch, and 10-inch bores were used in the Revolution.

These pieces were quite different in

Two British 8-inch brass howitzers mounted on excellent reproductions of the Muller carriage. Both pieces were cast of bronze by A. Schalch in 1727 and 1740. Both are inscribed, "Surrendered by the capitulation of Yorktown, October 19, 1781."

appearance from guns; their bores were only about three calibers long. They were particularly effective with canister and shell at close range when fired at low elevation. They could also deliver mortar-type fire with shell by removing a single carriage piece and depressing the breech.

Mortars were for high-angle fire alone. In fact, it was standard practice to build them for nonadjustable elevation fire of forty-five degrees and vary range by adjusting the powder charge. Muller advocated, however, the adjustable-elevation type. Those used during the Revolution varied from 4.4 inches to 13 inches in bore and from 85 to above 3,000 pounds in weight. Mortars were used frequently in the Revolution with varying results. About Boston, five large Continental mortars burst in early March 1776.

THE American fire from this type of piece was not really effective until Yorktown, although the British gunners once drove off Continental troops from Nook's Hill well after dark. The Continental engineer officers had laid out in daylight the defenses they planned to erect that night. The British gunners took their ranges and directions accordingly; one of their first shells caused several casualties in a single fatigue party.

In the summer of 1776, Knox's gunners tried to hit sailing men-of-war with mortar shells as they passed up and down the Hudson, but with no success. However, later on, both the gunners' skill and their ammunition improved. Knox personally laid many of his mortars at the siege of Yorktown. Their fire aided considerably in almost completely silencing the powerful batteries inside the fortifications.

The Ancient and Honourable Artillery Company of Boston, organized about 1638, had three fine brass 3-pounders, probably seven years old in 1775. Two served throughout the Revolution on the American side. Knox as well as other prominent artillery officers gained their early training in this organization.

Throughout the rest of the Colonies, however, there seems to have been little in the way of fieldpieces or of training to handle them. Most of the early pieces in the hands of the Continental batteries were small naval guns in storage since the peace of 1763 or captured at sea by privateers. British and Hessian officers in their diaries speak of iron pieces mounted in adapted naval carriages.

As already pointed out, the field artillery, along with other ordnance of the British Army, had been revised, improved, and simplified by Muller, beginning about 1755. These new "standardized" pieces were made of brass, but they were far from our modern ideas of standardization. Guns produced consecutively in one foundry sometimes varied almost 10 per cent in weight. Even appearance as to moldings, cascabels, and the like was not constant from year to year.

These Muller pieces, while the most desirable from the point of view of Knox and the Continental gunners, were rare. Obsolete iron guns were used until replacements were available. Further, many pieces of European manufacture were obtained in various ways.

The French sent us, even before the Alliance, many fieldpieces. The most common were two general models of 4-pounders, but 8-pounders also were received. In addition, some Hessian and other German artillery was taken at Trenton, Saratoga, and Yorktown. Little in connection with these pieces is now known, save that their pounds and inches were widely at variance with the French and English systems which differed moderately from each other.

A British 9-pounder had almost exactly the same nominal bore diameter as a French 8-pounder; however, the Hessian 3-pounders captured at Trenton had considerably larger bores than either the British 3-pounders or the French 4-pounders. Knox had one bored out to fire the British and Continental 6-pounder ammunition.

BOTH the Continental and British field artillery in the Revolution relied upon 3-pounder and 6-pounder guns and 5.5-inch howitzers. At various times the records show the presence of 12-pounder guns and 8-inch howitzers. Of the foreign pieces, only the French 4-pounders saw much active use in the field. Even these were mounted for service in the Continental artillery in copies of the British Muller-type carriages.

Transportation limited the size of fieldpieces during the war. A 6-pounder complete with carriage weighed between 850 and 1,100 pounds, which was about the maximum that could be transported satisfactorily on a single pair of wheels over Colonial roads by two horses. A 5.5-inch field howitzer weighed about the same. A 4-pounder French gun in the Muller carriage weighed a little more.

The 3-pounders which survive indicate a tube weight of from 150 to 400 pounds. This extreme variation can be explained in part by two fairly distinct functions of pieces of this bore diameter.

The field guns of the period actually used as such weighed from about 275 pounds and up. The lighter pieces were for use by infantry either in fortifications or mounted in wheelless carriages to be described later on. These light pieces are sometimes referred to as swivel guns.

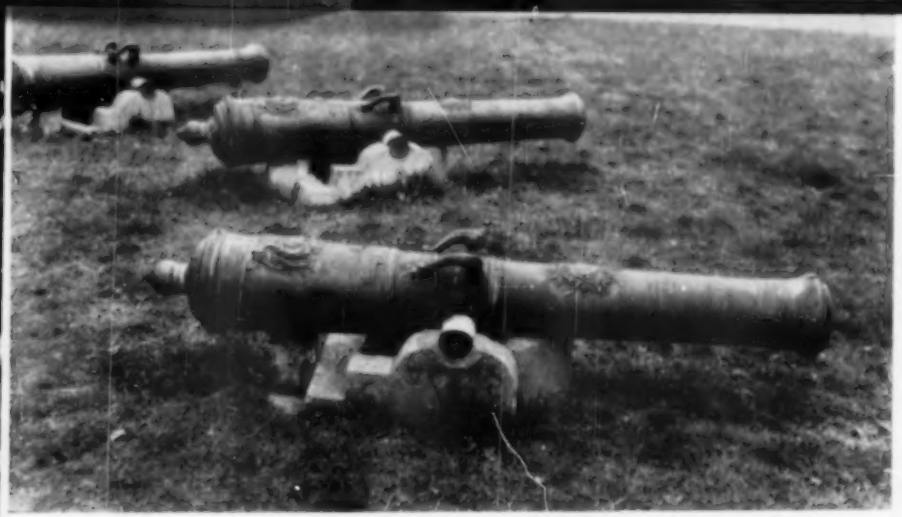
The standard 3-pounder field guns in a regular mounting would have weighed from 600 to 800 pounds which 4 men could handle fairly easily. In actual campaigns, it was deservedly the most popular size.

A FEW cannon were cast in New York and Pennsylvania very early in the conflict, and at least some of these were of brass. As soon as practical, most iron pieces in the Continental field artillery were replaced with guns and howitzers made of brass. French imports eased the shortage of fieldpieces.

Field artillery carriages in use in the Continental Army were undoubtedly of several types. The Muller carriage was, however, acknowledged to be the best and was used wherever possible. Although French tubes were imported in fairly large numbers, apparently few Gribeauval carriages came with them.

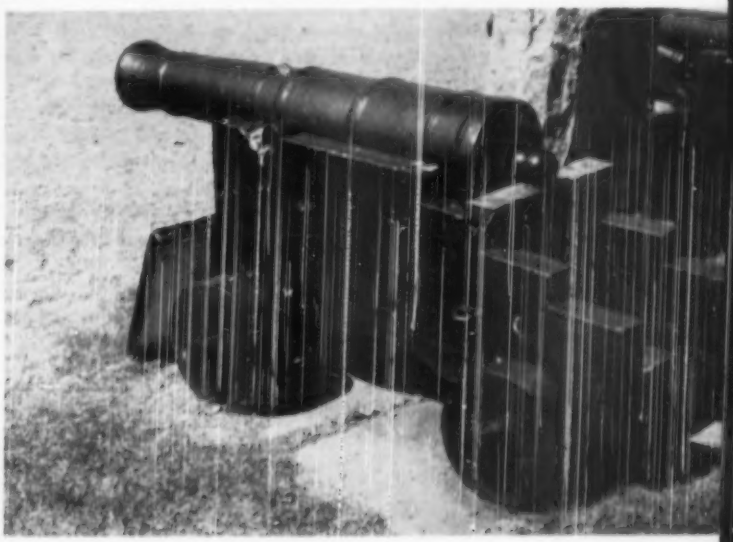
All axles of all Revolutionary carriages were of wood. The Muller carriage had a trail made by extending the cheeks in which the tube trunnions were mounted to the rear and securing them together at intervals with brackets or transoms. Muller's system has been known as the bracket-trail system.

The 6-pounder carriages took 50-inch-diameter wooden wheels with built-up iron rims. The 3-pounder carriages had 45-inch wheels of the same type. The light 5.5-inch field howitzers



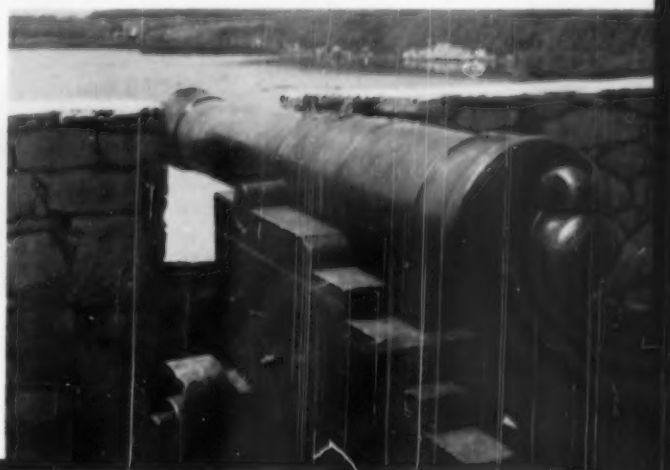
Two brass French 4-pounders, left foreground, now at Washington's headquarters at Newberg. Both were made by Berenger of Duay in 1756 according to Gribeauval's design four years before this design was generally accepted in the French Army. They have a bore diameter of approximately 3.375 inches and a lesser ratio of gun weight to shot weight than was common in earlier pieces.

Left, a British 5.5-inch brass howitzer made by W. Bowen in 1776 and bearing the cipher of George II under the usual crown. This was a common field howitzer of the Revolution and fired shell, canister, or grape. Below, British cast-iron 4-pounder taken from the British by Ethan Allan at Fort Ticonderoga. This particular cannon fell through the ice into the Mohawk River while Henry Knox was taking his siege train to Boston and was not recovered until after the war. It bears the cipher of George III and the "broad arrow" denoting government ownership. Now on exhibition at Fort Ticonderoga, it is unfortunately mislabeled a 6-pounder.



A battery of four British 6-pounders now at Fort Ticonderoga in naval-type carriages. The guns are the so-called "triple reënforced" cast-iron pieces frequently mentioned in Heath's Memoirs and other original references of the Revolution. These are 3.75 inches in bore diameter, 74 inches long without cascabel, and weigh between 1,792 and 1,895 pounds. All bear the cipher of George III.

A cast-iron British 24-pounder bearing the cipher of George III and the "broad arrow" now mounted at Ticonderoga facing Lake George. Bore diameter is 5.875 inches; piece is 118 inches long excluding cascabel; weight is between 5,488 and 5,522 pounds. Weapons of this size were too big for most purposes during the Revolution, although a few were used by the Continental Army around Boston.



were mounted on similar carriages with short trails, giving higher elevation for regular and ricochet fire. These pieces could, as already pointed out, also be used to deliver high-angle mortar-type fire by removing a block of wood from between the cheeks of the carriage and dropping the breech of the piece down between them.

Limbers were supposed to be standard, but research in contemporary accounts indicates they were not. Sometimes the limber wheels were the same size as those of the carriage; usually they were smaller. Since no load beyond the weight of the limber itself plus a small part of the weight of the gun-carriage trail was carried by these wheels, their size and width made little difference.

The limber commonly had shafts for one horse; additional animals were hitched in tandem in front. This arrangement was poor as the piece was not nearly so maneuverable as with the later, pole-type, side-by-side limber. Further, it was inconvenient to employ more than two horses and almost impossible to employ more than three for field artillery.

RADICALLY different carriages known as the "galloper" and the "grasshopper" saw some service. A few 3-pounders and light 6-pounders were mounted on a split-trail type of carriage known as the "galloper." The trail itself was in the form of two heavy shafts between which a single large and vigorous horse could be hitched. Actually, this was a combination of carriage and limber, the shafts being stout enough to withstand the thrust of firing.

The "grasshopper" carriage was for even smaller pieces and had no wheels. It was a sort of cradle in which a swivel gun could be mounted. Two or more men would carry it on a battlefield; on the march it was carried in a wagon. These pieces were in theory integral parts of the arms of infantry after Von Steuben's reorganization and training. Each battalion was supposed to have two of them, and they were quite separate from the field-artillery organizations.

During the Revolution, charges of gunpowder were put up in cylindrical cloth bags, usually by the artillerymen themselves. Solid shot, shell, grape, and canister were used as projectiles, but solid shot was by far the most common. Explosive shell was used in limited quantities from mortars and howitzers. Grape and canister of various sizes are still being recovered from the battlefields.

Field-artillery ammunition was carried in boxes mounted on either side of the gun carriage. Additional supplies were carried in tumbrils, carts, and wagons of any available type; neither caissons nor limber chests had come into use as yet.

Field artillery was the bad-weather weapon. At Trenton and elsewhere the muskets of the infantry were temporarily useless because of wet priming, but the fieldpieces fired with commendable regularity.

ARTILLERY drivers were civilians in the Revolution both in the Continental and British Armies. They usually walked beside their teams but could be mounted on a separate animal. All battlefield artillery maneuvers on both sides during the Revolution seem to have been done by the gun crews themselves manhandling the pieces into position by use of dragropes (prolongues) and handspikes.

Knox's pieces and his gunners were in the very forefront of the war from Boston to Yorktown. Their profession called for long and arduous training and experience that they just didn't have, yet they somehow contrived to do a good job from the very beginning.

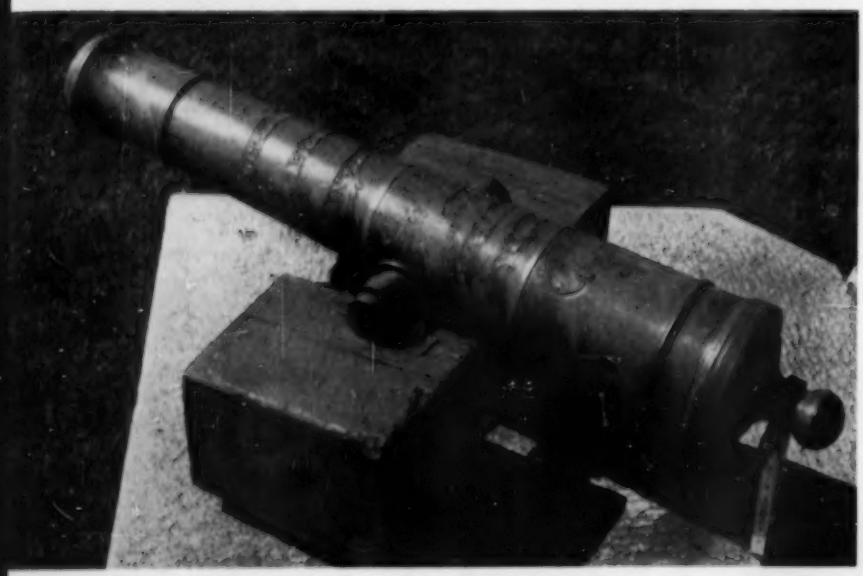
The year 1776 was a bleak one indeed after the British returned from Halifax. Howe successively pushed the Continental Army from Long Island, Manhattan Island, and a good deal of lower New York State. Washington was finally driven across New Jersey into Pennsylvania. His army shrank from more than 20,000 to about 5,000 in the course of five months.

It is remarkable to record, however, that Knox was able to save every single gun during the retreat across New Jersey. The artillery alone contested the river crossings and did almost all the fighting during this retreat. The guns consistently came last. These same guns were of tremendous importance in Washington's all-important counterpunches at Trenton and Princeton. Four guns were at the heads of each of the two Continental columns at Trenton; they opened fire before the line infantry was up.

WASHINGTON and Knox were using a proportion of fieldpieces to infantry of about 8 per 1,000; about 3 per 1,000 has been normal from Cromwell to World War II. The organization and *esprit de corps* of the artillery was extremely good.

It should not be forgotton, however, that the Revolution, like all the rest of

An extremely light bronze 3-pounder. Thought to be one of two pieces mentioned in Burgoyne's records as having carriages enabling transportation in two loads on horseback. Cannon inscribed "Surrendered by Convention of Saratoga, October 17, 1777."



our wars, was basically fought by infantry. The artillery, of tremendous value actually and psychologically in some battles, played little part in other actions. At Bunker Hill in 1775 the professional British officers were amazed at our small-arms fire which inflicted upon them close to forty per cent casualties in a few minutes. This fire came from untrained and practically unorganized militia in part from behind breastworks. After Von Steuben's training, the Continental infantry fought the British in the open at Monmouth.

Many Continental officers were in favor of aimed fire made possible by the American rifle. The rifle was certainly superior on the frontier where the fighting was mainly Indian style, and during the war there were several actions where rifles were very useful even in pitched battles. However, they just could not deliver the volume of fire necessary for successful infantry tactics in the open. The smoothbore musket had been supreme for more than a century, and it was to remain so for another seventy-five years.

AT the beginning of the Revolution, there was in America one major type of military musket—the British Brown Bess. This weapon, already in use in the British Army and in America for half a century, had no equal in rapidity of fire, reliability, and general hardiness under field conditions. It was, of course, extremely inaccurate at anything but close range, but it was not expected to function beyond about one hundred yards.

Large numbers of these weapons had come to America to arm the militia during the extended wars with France. Some few Continental organizations such as Smallwood's Maryland and Haslet's Delaware Infantry purchased these weapons new from England just before the start of hostilities. Many more were captured from British forces in the field and after their various evacuations and surrenders during the war.

The term Brown Bess is generic; it was applied loosely to British muskets of several different, but related, models. There were variations even in successive muskets of a single model from the same source.

The Continental Army had little in the way of equipment initially. As the war wore on, things were produced or improvised. However, supply was always a problem. Manufacturing of munitions of war was difficult in this country.

Bronze 5.5-inch field howitzer made by Byers in Philadelphia in 1777. Perhaps the oldest extant piece of artillery made for the U. S. Government. The inscription, "U. S.," engraved between the trunnions was not used before September 1776.

About Boston, Washington's whole strategy was based upon the sad fact that there was often not enough powder in the Continental magazines for even a brisk skirmish. The small arms and artillery were present in substantial numbers and fair quality, but there was seldom sufficient ammunition to fire all the pieces even half a dozen times. The new nation slowly remedied the scarcity of powder by making its own and importing from France. However, other scarcities continued.

Further, the quality of many things was extremely poor. One of Washington's most promising offensive opportunities was lost when a sudden rain soaked the cartridges of the Continental troops right through their poplar and skimpy leather pouches which were not rainproof. The British forces, exposed to the same downpour, but with better designed and fabricated pouches, lost hardly a cartridge. Clothing, belts, packs, blankets, tents, and boots were all in short supply; their quality was frequently poor. However, none of these lacks, or even a combination of all of them, proved fatal.

WE should not judge the eighteenth-century ordnance efforts of our forefathers by the standards of the Atomic Age. Their weapons were simple and lacked the precision and power of modern arms. The Continental armies, save for militia serving for a few weeks only, seem to us today tiny even in proportion to the Colonial population. But this was before the days of total national war.

Both men and material were limited, but so were those of other nations at that time. The Continental Congress refused to impose taxes; real conscription was impossible. The economy, means of transportation, and ways of thought were against bigness and complication in war.

WE had, however, in this our first national effort a knowledge of the ordnance we wanted, an ability to obtain it, and finally the power to use it effectively. Tim Murphy of Morgan's riflemen shot General Fraser at Bemis Heights at a range impossible for the British musket. Knox and his men, over an icy river and through snow, rain, and sleet, transported and employed their fieldpieces to win a victory at Trenton scarcely obtainable by any other means. At Guilford Court House the First Maryland Continental Line broke a battalion of the British Guards.

If we can do as well with what we have as they did with what they begged, borrowed, and captured, we can face the future with confidence. But it is doubtful that we will ever inflict so many enemy casualties, percentagewise, in so short a time as our forefathers did at Bunker Hill.

Defense in Atomic War

It will not be sufficient to know that the enemy has only fifty possible tricks and that we can counter every one of them, but we must be able to counter them almost at the very instant they occur

Dr. John von Neumann

Member, United States Atomic Energy Commission, Washington, D. C.

Paper given at the Kent Seminar, 37th A.O.A. Annual Industrial Preparedness Meeting, New York City, December 7, 1955.

THE introduction to any and all applied science via the channel of military science, while it was rare in the one or two generations that came before us, is not so paradoxical. Without trying to reminisce about things long past, this particular circumstance has had, since Archimedes and Leonardo da Vinci, a very long pedigree.

I would like nevertheless to reminisce just a little. My particular introduction occurred at the Ballistic Research Laboratories in the early years of World War II. It is remarkable to consider today how small in numbers was the manpower trained for this kind of applied science, and in particular for military matters. This was especially true in the theoretical field and more especially in my field—mathematics.

It was astounding that there were considerable numbers of supposedly very sophisticated specialists in very highly complicated fields of effort, and yet how very little we knew about the matters to which we were to be introduced.

THERE the guidance and the example of somebody who knew what this was all about were tremendously valuable. This whole relationship of being supposedly an expert in one way and yet a complete ignoramus in the way which happened to matter at that time is hard to describe.

I assume it is best illustrated by a story which I heard recently about the American Indian who registered at a New York hotel and made two X's for his name. When asked what this signified, he said that the first X meant "Chief Bald Eagle." When asked what the second X meant, he said, "Ph.D." We were all making our X's in this fashion!

The other thing which was very remarkable was how this transformation took place in other fields and specifically how the institutions expanded which were connected with the Ballistic Research Laboratories.

The first vista I got of this was at the Ballistic Research Laboratories, where, first under Colonel Zornig and then under Colonel Simon, and always under the guidance of Dr. Kent, the institution expanded fiftyfold. And how the complexity of what went on grew!

Quite apart from facts referred to, it was very remarkable that the laboratory was one of the pioneers in supersonic wind tunnel building in America. It was absolutely the pioneer in the field which concerned me very closely afterward—the building of modern electronic computing machines.

The first modern electronic full-scale computing machine was built at the University of Pennsylvania for the Ballistic Research Laboratories, and for years afterward the only ones that could operate on the scale required were available there, and only there. It took quite some time before a really high speed machine was developed independently elsewhere.

Since then, the complexity and the sophistication of the weapons business has been increasing very rapidly from year to year. I should like to mention, as an example of this, the phase of computing machines. It is probably true that since 1945 the over-all capacity of these machines has nearly doubled every year.

This is astounding because over a period of ten years it means a thousandfold increase. Yet it is true that the increase that has occurred is a thousandfold in certain respects. I know of one instance where it actually has been three or four thousandfold since 1946.

IT is astounding to what extent the use of the computing machine has spread, and in some fields today it is very hard to imagine how one would go on working without such machines.

One of them is, of course, ballistics in the very complicated forms it now has assumed. Ballistics has progressed from the calculation of firing tables for more or less conventional use into the calculation of firing tables for antiaircraft artillery, then into the more complicated field of air-to-air firings, and now into the peculiar and complicated field of missile-trajectories guidance.

At the present time a high-speed computing machine based on the principles that were introduced in the middle 1940's is an absolutely necessary condition for these things.

Another field is systems analysis and methods of operational research, the determination of expected characteristics of future weapons, and the determination of what the future weapons, on which one still has latitude to choose characteristics, ought to be like in order to be optimum. The sorts of things one can do in this area now would have baffled the imagination ten or fifteen years ago.

The manner in which one now calculates the performance of a weapon system consists of taking it through a military maneuver, an engagement, or a series of engagements on a computing machine. Chance factors are injected and the result calculated. Then this is repeated a few ten thousand times and the expectation found.

This is done for hundreds of trial computations to discover in which regions one finds the optimum. All this would have meant large-scale military maneuvers and large-scale operations if done in reality. One could never have varied all the parameters.

Many of these techniques originated in the Ballistic Research Laboratories, particularly in those sections of it which owe their existence to the work of Dr. Kent.

I WOULD like to discuss also the probable impact of the use of atomic weapons on the responsibilities of the field of ordnance and the tactics and strategy of warfare. It is quite clear that the type of system analysis which has been applied to conventional weapons will have to be applied in the field of atomic weapons with even more sophistication on an even larger scale because the changes which this will bring to military procedures are likely to be even more drastic.

Let me point out a few things which immediately come to mind which show how different not only the situations are in which these things are used but even how different the methods must be with which they are approached.

Fundamentally, what is achieved by the use of atomic weaponry is just an increase in firepower. This in itself is not very revolutionary. The history of all known warfare and military effort has been nothing but a history of the increase in firepower.

It is well known what the consequences are. The most obvious one is the dilution of armies on the battlefield. It is clear that if you can concentrate a much greater power of destruction on a small area you can afford to keep less people and less equipment in that small area. If you deploy your maximum effort in people and equipment, you will have to cover a greater area.

THE increases of firepower which are now before us are considerably greater than any that have occurred before. This increase is particularly obvious if you discuss it not in terms of firepower per man in the field but in terms of the increment of firepower per delivery vehicle in the field and specifically per airplane, since delivery by aircraft is the one which was utilized first and its applicability was most obvious. However, it was plainly not the only one.

The entire tonnage of TNT dropped on all battlefields during all of World War II by all belligerents was a few million tons. We delivered more explosive power than this in a single atomic blast. Consequently, we can pack in one airplane more firepower than the combined fleets of all the combatants during World War II.

The Air Force organization which delivered those two or three million tons of explosives in World War II amounted to several million people. Today, the organization which makes one drop in the million-ton range from one airplane may number from a few people to a hundred people, depending on how much of the supporting organization you count. In this sense, you can judge what incremental concentration has been achieved.

You must consider, however, that the applications in the form of airplane delivery are still relatively primitive. In fact, just because of the overwhelming power involved, they have led to a certain de-differentiation. At the end of the high-explosive age of aërial warfare there were large numbers of types of bombs—incendiaries, high-explosive, and fragmentation bombs—made in very different ways, arranging their essential components differently, and really operating on different physical principles.

AN atomic bomb can produce a number of different effects, and the military use of it may emphasize different effects such as blast or heat or radiation. Nevertheless, the bomb is essentially the same. The weapon is not changed very much by the manner in which it is used.

It is not at all unlikely that this de-differentiation will go on and will last when other forms of use are discovered. Yet the obvious thing will probably happen in the end, and if these weapons become paramount for ground warfare it is very hard to imagine that a considerable differentiation will not have to take place, or rather that the differentiation which already exists will not have to perpetuated.

The way to fight a tank with atomic energy is not the same as the way to fight a large body of infantry or to attack a large static fortification. In fighting large bodies of infantry, the weapons of aërial delivery probably can be used. It is plain that in fighting an object like a tank the technique is quite different.

All these things will require weapons systems of high differentiation, and the methods of operation which were applied to high-explosive warfare in the last war will have to be redeveloped.

In the past, when a weapon system was first developed, if it was used in the proper way with sufficiently high concentration and intensity it was usually

"It is astounding to what extent the use of the computing machine has spread, and in some fields today it is very hard to imagine how one would go on working without such machines. One of them is, of course, ballistics in the very complicated forms it now has assumed. Ballistics has progressed from the calculation of firing tables for more or less conventional use into the calculation of firing tables for antiaircraft artillery, then into the more complicated field of air-to-air firings, and now into the peculiar and complicated field of missile-trajectories guidance."

very potent for a while until countermeasures were developed.

Any one who had the last move in this game had the advantage for a while thereafter. Then when another countermove was made, the advantage shifted. This advantage oscillated to and fro, with the oscillations always decreasing. In the late stages of the use of a weapon at a high level of sophistication the return for a new trick was much smaller than in the early stages.

There are many examples of this. A particularly interesting one is in the history of submarine mine warfare where this peculiar equilibrium of measure and countermeasure was developed to such a degree that after about a year or so the damage actually done by mines to the enemy was smaller than the economic effort the enemy had to exert in order to defend himself against mines.

IN the end, I think we probably harmed the Germans much more by forcing them to divert their rather scarce copper into minesweepers than by the ships we actually sank. I think they did as much harm to us by forcing us into the convoy system or into the use of special shipping lanes as by the ships they actually sank.

With the atomic weapons there will be the following oddity, and it will take a great intellectual effort and some very brilliant ideas not yet held by anybody to solve the problem we are faced with. This is particularly clear when we consider nuclear weapons in their expected most vicious form of long-range missile delivery. A situation may arise where for a known weapon, such as a particular type of long-range missile, there is probably a defense against it.

But there is also probably a countermeasure against the defense. Furthermore, it is utterly hopeless to produce defenses against all the countermeasures the enemy may use, not because we don't know how to counter but because we can't use all the countermeasures at the same time. The enemy has the enormous advantage in that he will only use one trick, and if we try to use all our countertricks at once, the system gets too cumbersome.

This was true in the past but most specifically of aërial warfare. If the enemy came out with a particularly brilliant new trick, then you just had to take your losses until you had developed the countermeasures, which may have taken weeks or months. The period of one month is probably reasonable for a very brilliantly performed counter-countermove. This duration is now much too long, and the losses you may have to take during this period may be quite decisive.

I THINK an introduction of one particular radar trick (which the Germans countered in three or four days), caused them to lose the city of Hamburg. On the other hand, the introduction of very fancy new mines which could be countered only after a few months of work, led to exorbitant losses of shipping only for a limited time, and it soon became possible to reduce these losses to a bearable level.

The difficulty with atomic weapons, and especially with missile-carried atomic weapons, will be that they can decide a war, and do a good deal more in terms of destruction, in less than a month or two weeks. Consequently, the nature of technical surprise will be different from what it was before.

It will not be sufficient to know that the enemy has only fifty possible tricks and that you can counter every one of them, but you must also invent some system of being able to counter them practically at the instant they occur.

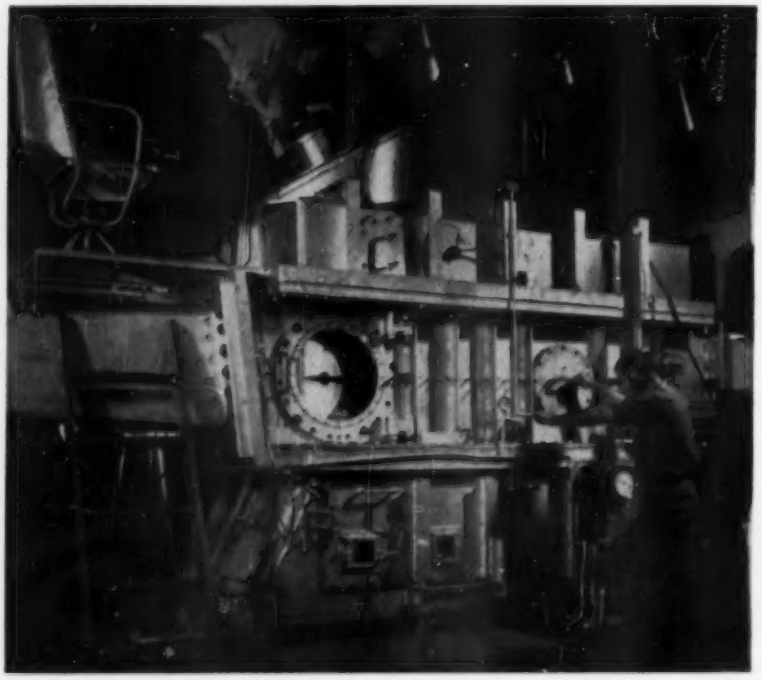
It is not easy to guess how this is going to be done. Some of the traditional aspects of the use of the same weapon for several purposes and of limiting its use until you need it for defense may have some of the elements of an answer.

However, this will probably mean that you will be forced not to "do your worst" at all times, because then when the enemy does his worst you cannot defend against it, and the one thing you can put on at an instant's notice, if you are strong enough, is power stepped up to the limits of your capabilities. Hence, you may have to hold this trump card in reserve.

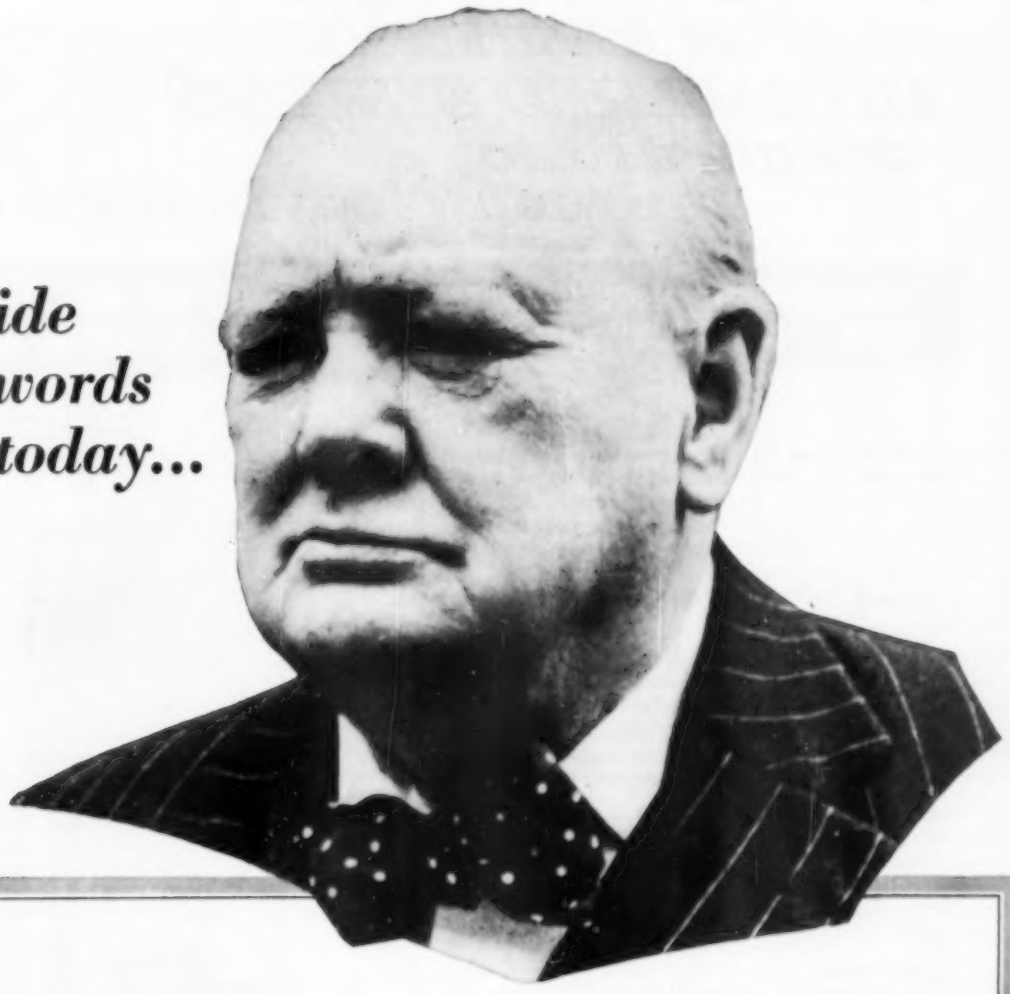
Without going further into the details of this matter I just wish to indicate generally that quite unconventional methods of systems analysis and of operations analysis will bear fruit in the future, as they did in the past.

THIS is, I think, an especially fitting way to close. It brings us back to emphasize the enormous importance of the most powerful weapon of all; namely, the flexible type of human intelligence which we admire in Dr. Robert H. Kent.

Model ballistic missiles are tested in Aberdeen's supersonic wind tunnel.



Guide words for today...



"The day will come when it will be recognized without doubt throughout the civilized world . . . that the strangling of Bolshevism at birth would have been an untold blessing to the human race."

WINSTON CHURCHILL

The day Churchill foresaw is here. The iron grip of Communism now holds more than one third of humanity in bondage. It should be clear to all thinking people that mere "peaceful coexistence" will not halt the Kremlin's march to world domination. Whatever their current "cold war" tactics may be, the Communists offer nothing to the human race but poverty, bloodshed and suffering.

W B Gray

PRESIDENT

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Air appliance engineers had been striving for years to perfect a valve of this kind, which would constitute an effective air-lock between the high-pressure differential inside a pneumatic conveying system and the atmospheric pressure outside. Now they have succeeded. And the number of purposes to which the valve can be put in industrial conveying is enormous.

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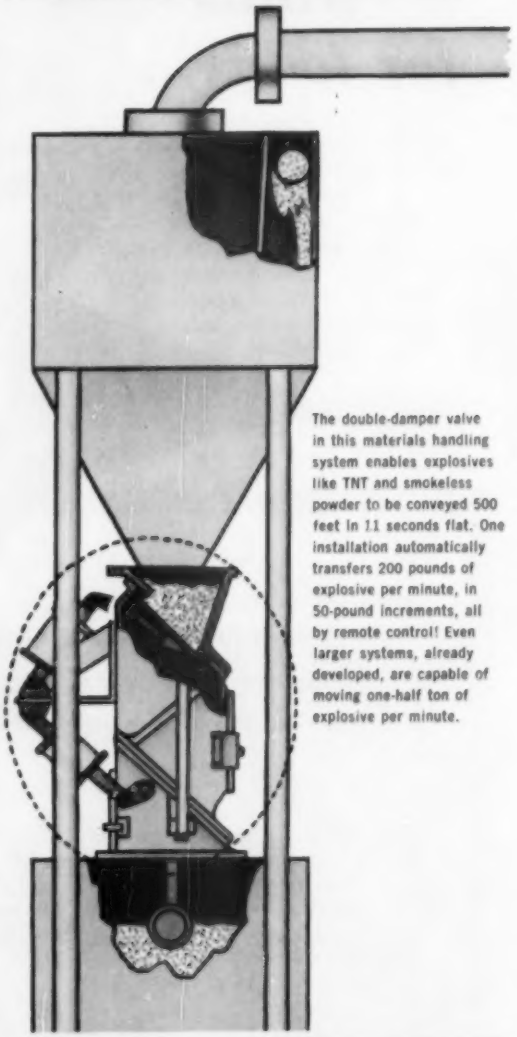

The double-damper valve in this materials handling system enables explosives like TNT and smokeless powder to be conveyed 500 feet in 11 seconds flat. One installation automatically transfers 200 pounds of explosive per minute, in 50-pound increments, all by remote control! Even larger systems, already developed, are capable of moving one-half ton of explosive per minute.

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MAY-JUNE 1956

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U.S. Army Photograph

Electronic specialists at Ft. Monmouth SCEL Laboratories checking out radar and computing system designed for field use.

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This is one of a series of ads on the technical activities of the Department of Defense.

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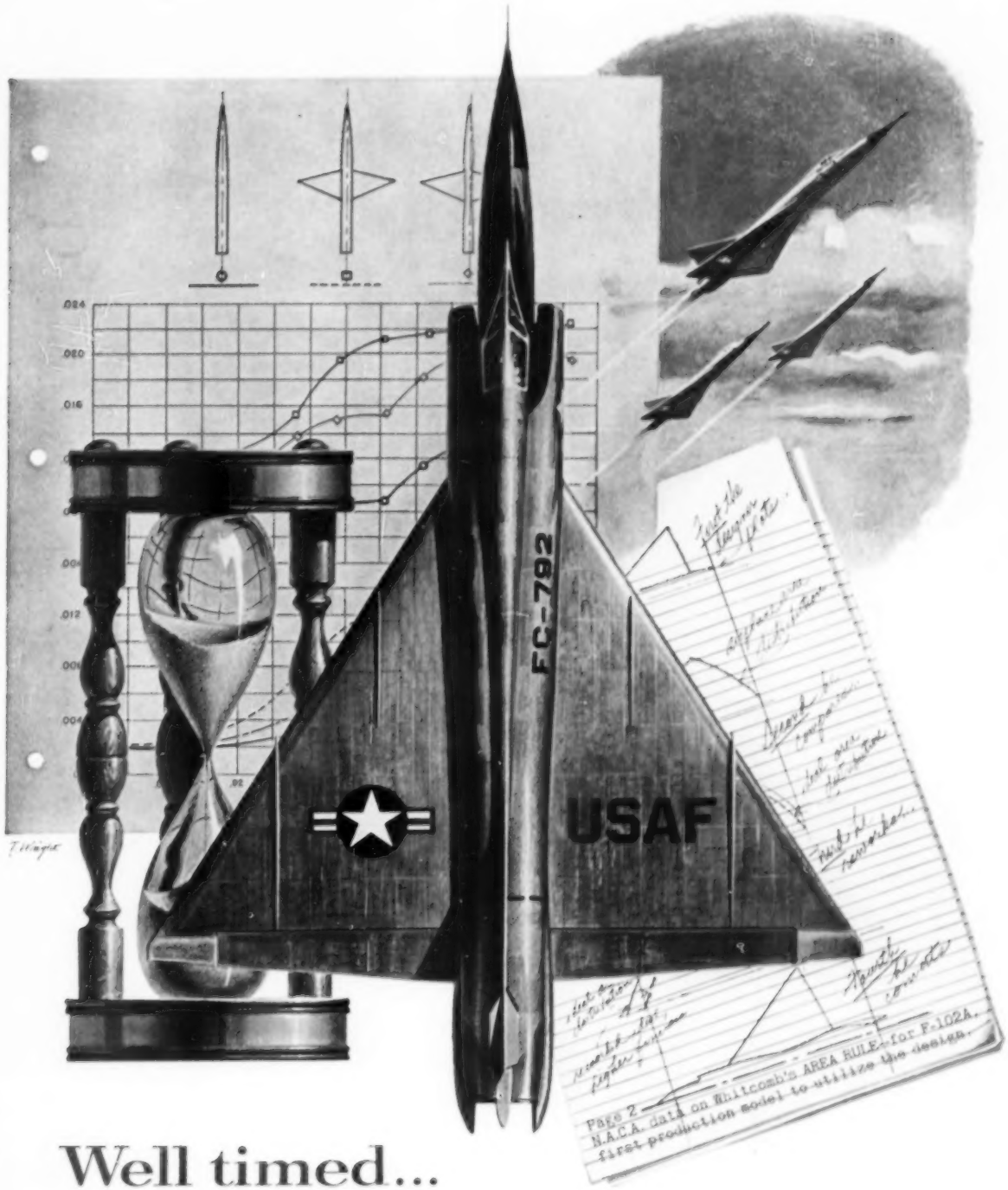

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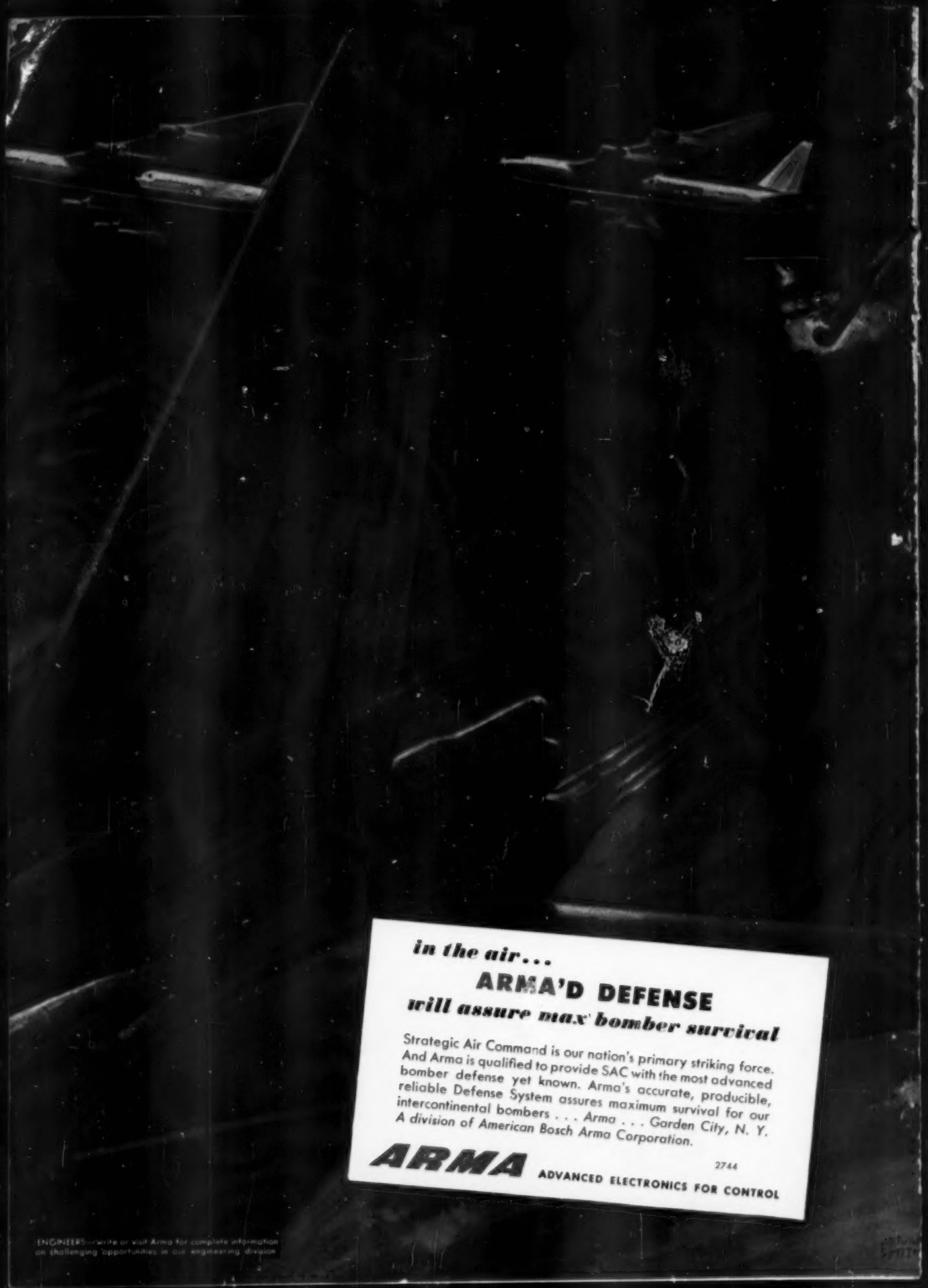

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